

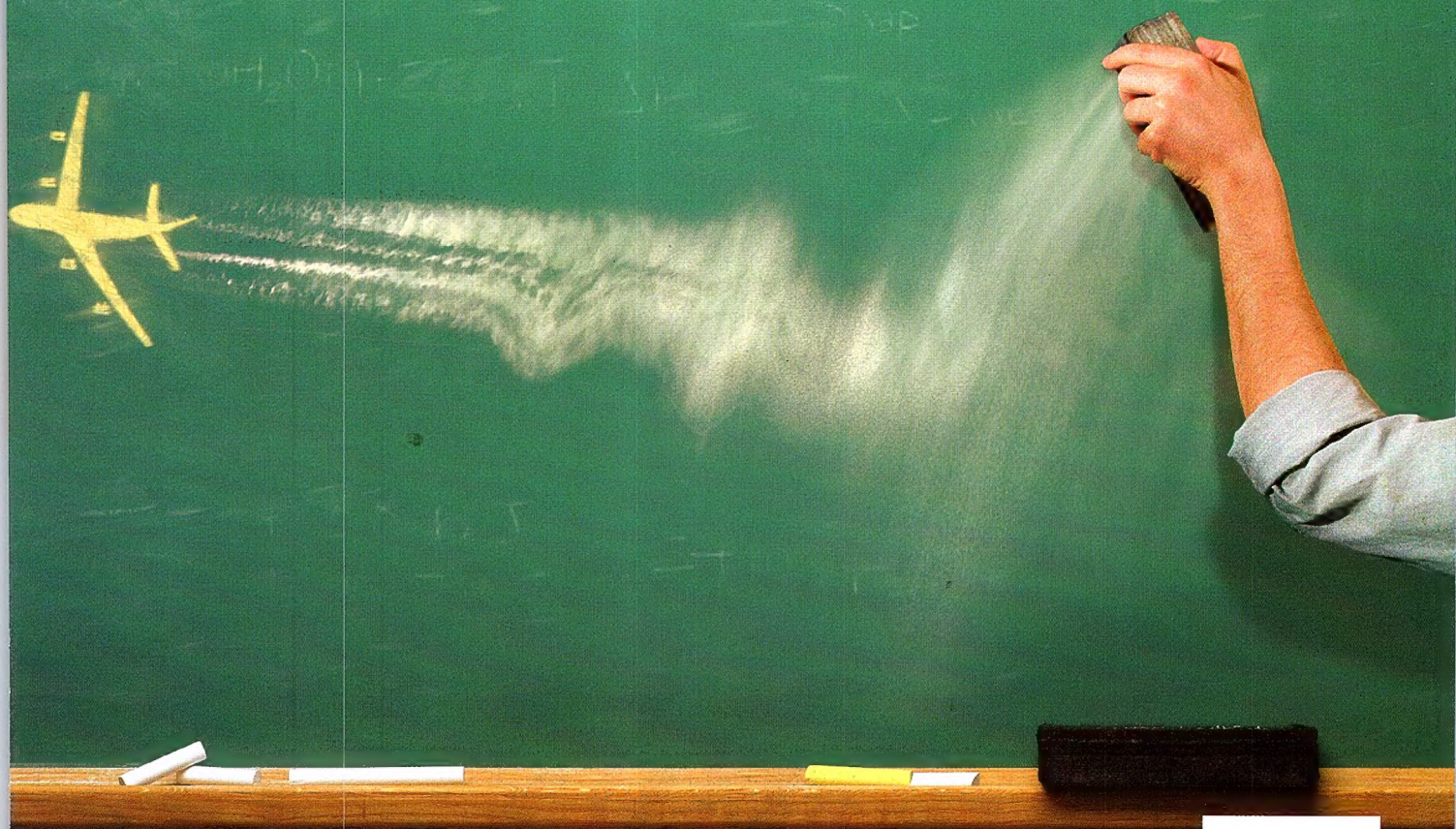
WEEKLY NEWS IDEAS INNOVATION 26 FEB 2007

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MARVIN MINSKY
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Bust enemy tanks, not your own p 28

NEWS

EDITORIAL

If we are serious about reducing sex crimes we cannot ignore the people who pose the biggest threat **3**

UPFRONT

Immigrants perish in Arizona desert; climate of change on Capitol Hill; gene privacy boost; new danger symbol for radiation; Australian astronomers don't trust NASA's plans for Mars; DNA "barcoding" discovers new species; fingerprint scheme to solve old crimes **4**

THIS WEEK

Should sexual offenders be kept locked up after their jail term is over? **6**
 A Manhattan project for biofuels **12**
 Brain's back-up circulation could cut damage caused by strokes **14**

IN BRIEF

How sleep makes sense of memories; when it pays for males to be big; getting the best from garlic; sad fate for disintegrating galaxies **17**
 Adult mice grow replacement teeth; IVF does increase birth defects; time-travel discovered in scrub jays; flame-retardant Chinese birds **18**

INSIGHT

Torture: what's missing from Jack Bauer's approach in 24? **13**

TECHNOLOGY

Give an owl a hoot on your cellphone; one-stop shop for disaster advice; living data storage in bacterial DNA **27**

FRIEND OR FOE?

The US and its allies are trying hard to improve a dismal record of attacking their own soldiers **28**

How to produce less space junk **30**
 Kill a cancer by filling it with holes **30**

FEATURES

COVER STORY

GREEN SKY THINKING
 New technologies could clean up aviation, but they'd better be quick **32**

VIRTUAL OUTBREAK

Online games are the perfect laboratory for studying real human behaviour **39**

SUPERIMMUNE

A little genetic tweaking could give our immune system the power to fight off even the most devastating diseases **42**

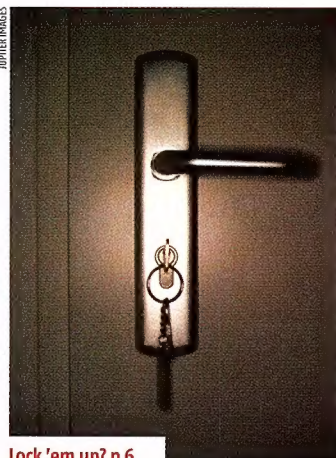
FOREVER GROWING BUBBLES

What do space-time and soap suds have in common? **46**

ON THE COVER

Green skies thinking, page 32
 Super immunity, page 42
 Marvin Minsky, page 48

JUPITER IMAGES



Lock 'em up? p 6

OPINION

COMMENT AND ANALYSIS

Costly vaccines are no substitute for good healthcare, says Ralph W. Moss **20**

LETTERS

Climate responsibility; furniture, fires and CO₂; trauma stress; cancer hope **22**

INTERVIEW

Veteran AI researcher Marvin Minsky thinks emotion is the key to success **48**

REVIEW

Islam is no more hostile to science than Christianity, argues John Gray **50**

TURNING POINT

A Buddhist angel's rescue mission **51**

HISTORIES

Canada's deadly tsunami **52**

THE WORD

Drink a toast to terror **54**

BOOKENDS

Penicillin story; uncertainty; cell life **54**

REGULARS

50 YEARS AGO
 Banking enters the electronic age **12**

ENIGMA **51**

FEEDBACK **56**

THE LAST WORD **65**

JOBS **55**

"Even persistent child abusers may not be sufficiently fixated on sex with children to qualify as paedophiles"

The pitfalls of trying to lock up former sex offenders, page 6

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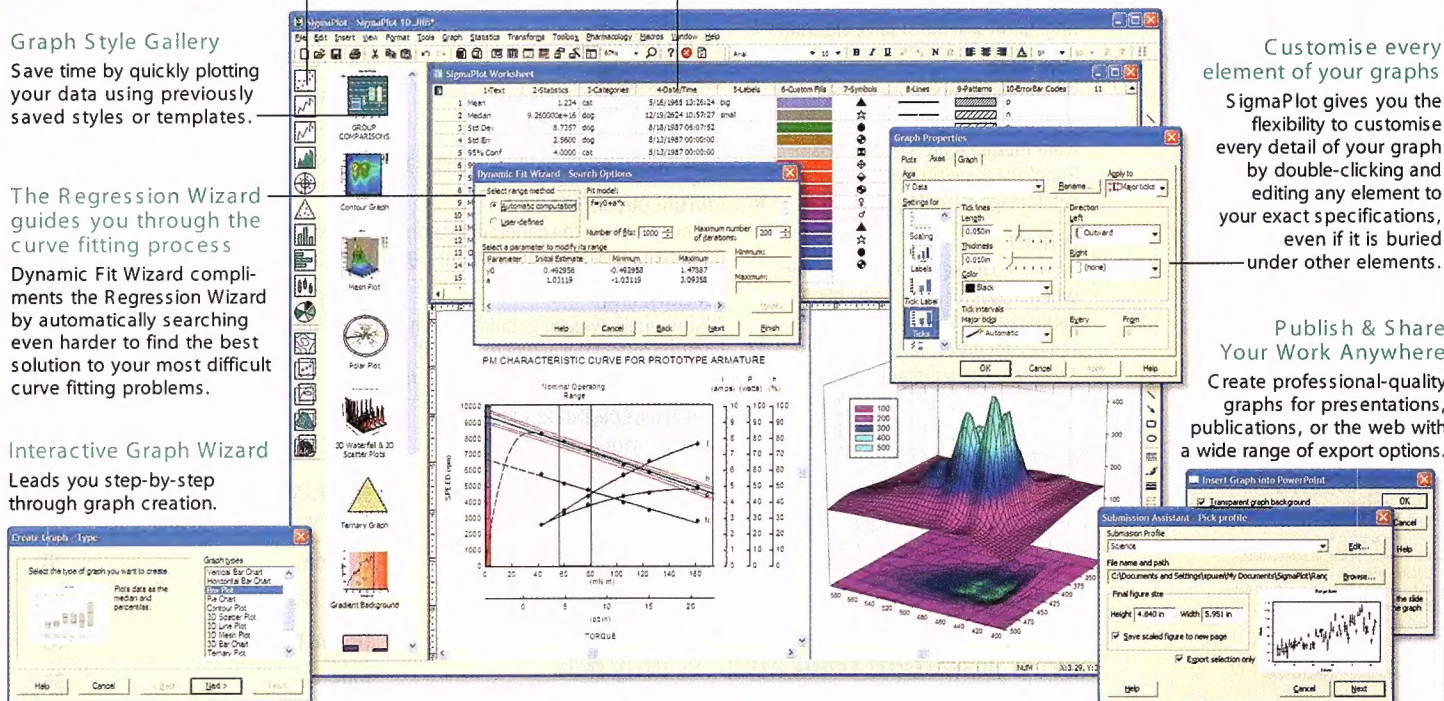
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An uncomfortable truth

Most sex crimes are committed by people we might count as friends

SEX offenders are a breed apart, notorious recidivists who are driven by deviant sexual desires. That, at least, is the common perception. The facts are rather different. Most sex offenders do not fit any psychiatric diagnosis related to sexual deviance. Reconviction rates for this group as a whole are relatively low compared with other types of criminals. Most importantly, the majority are not a breed apart.

The label "sex offender" is a rag-bag term that covers individuals who have committed a wide range of offences. Some are nasty opportunists for whom rape or child abuse is just one in a long string of diverse crimes. Most knew their victims: they assaulted acquaintances, family members or friends. Others are young men who had sex with under-age girlfriends. The stereotypical predator, persistently targeting vulnerable strangers, is rare.

While it is true that convicted sex offenders are more likely to commit a further sex offence than other ex-cons, they are not the group that society has most to fear from. Given the larger numbers who are convicted of burglary, violent assault and other non-sexual offences, you or your loved ones are more likely to be raped by someone previously jailed for one of these crimes. Yet even this group does not present the greatest threat. Most of those convicted of a sex crime have no prior criminal record, and worryingly large numbers of offenders get away with it.

Ida Dickie, a forensic psychologist at Spalding University in Louisville, Kentucky, conducted a survey of men seeking casual work in Ottawa, Canada. Her as yet unpublished research shows that 42 per cent admitted either to having raped an adult, or having had sex with a minor at least five years younger than themselves. Raymond Knight, a psychologist at Brandeis University in Waltham, Massachusetts, obtained similarly disturbing results while conducting research into the roots of abuse against women (*Annals of the New York Academy of Sciences*, vol 989, p 72). In a sample of blue-collar American men, 36 per cent admitted to having done at least one of the following: using or threatening force in an attempt to obtain sex from a woman; having or attempting to have sex with a woman who was too drunk or high to say no; or plying a woman with drink or drugs

to that end. Such behaviour is not the preserve of working-class men: some studies suggest that about 15 per cent of women attending US colleges fall victim to rape or attempted rape, committed by privileged young men.

Child sexual abuse is harder to investigate, but the evidence suggests that it is fairly common, vastly under-reported and mostly committed by outwardly normal men against

"We should look beyond the few perpetrators who get caught and see the majority of sex offending for what it really is"

their own children, or the children of their families or friends.

Despite this evidence, responses to sex crime appear to hinge on the false assumptions that previously convicted sex offenders pose the main threat, and that imposing severe

penalties on them will solve the problem. In the US, huge sums are spent on indefinite "civil commitment" for those judged to be dangerous sexual predators (see page 6) – never mind that keeping these people locked up will barely dent the sex crime statistics.

We should look beyond the few perpetrators who get caught and see the majority of sex offending for what it is: the manifestation of widespread, wrong-headed attitudes towards women and sex. Rather than being an identifiable delinquent out-group, rapists and child abusers are more likely to be the kinds of people we count as friends, colleagues and neighbours. The evidence is overwhelming that the biggest opportunity for reducing sex crimes lies in reaching apparently normal men with no criminal record. We need to take a hard look at the attitudes that lie behind these offences and re-establish what is acceptable sexual behaviour.

A concerted effort to boost reporting, detection and conviction rates will help bring more rapists and abusers to book for their crimes. Greater emphasis on "situational" crime prevention is also needed, to help us check criminal acts. That does not mean a return to the twisted thinking that blames rape victims for being "provocative", but it can warn against obvious risk factors, such as the abuse of alcohol or drugs by both perpetrators and victims. ●

Upfront

FATAL ATTRACTION OF THE US

Build a fence, and people will just go around it – or die trying. So concludes a study that looked at the effects that heightened security on the US-Mexico border has had on illegal immigration.

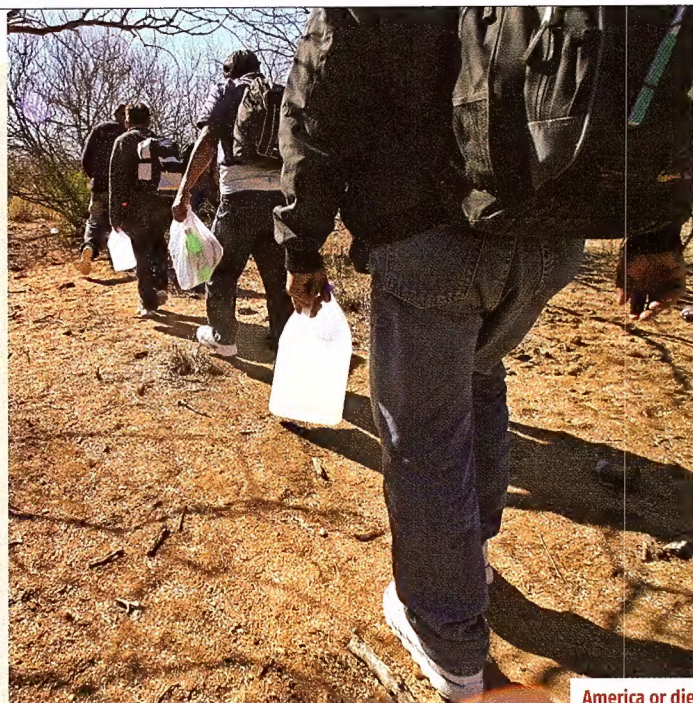
Over the years, millions of would-be immigrants have attempted to cross the border illegally into Texas and California. Now fences and increased surveillance close to border cities in these states, such as El Paso and San Diego, appear to be funnelling illegal immigrants into thinly populated areas of Arizona. In this harsh desert terrain they have been dying in record numbers.

The study, published last week by the American Immigration Law Foundation, is based on a detailed examination of more than 900 autopsy reports from Pima county, Arizona, from 1990 to 2005. During this time, there

was a 20-fold increase in illegal immigrant deaths in the county, which borders Mexico.

"I think the numbers are pretty damning," says Raquel Rubio-Goldsmith of the University of Arizona, Tucson. "It's clear that recent security build-ups are not deterring illegal immigrants from trying to cross. They are simply attempting riskier crossings." Plans to build fences along parts of the Arizona border will only result in more fatalities, she says.

Meanwhile, Border Angels, an immigrant-rights advocacy group, is calling for a comprehensive overhaul of US immigration policy. On 17 February, the group completed a two-week tour of the border from California to Texas, publicising the fact that more than 3000 immigrants have died trying to cross it since 1994.



America or die

Climate angst

INTERNATIONAL momentum to combat climate change is growing, even in the gas-guzzling, notoriously sceptical US. At a meeting on Capitol Hill last week, legislators and officials from 13 countries including, crucially, China and India, agreed a plan for combating global warming once the Kyoto protocol expires in 2012.

The plan includes setting an absolute global limit for emissions of carbon dioxide so that future airborne concentrations stay within 450 to 550 parts per million. The concentration in 2005 was

and creating a global market for trading CO₂ credits.

Adding to the momentum, European environment ministers met on Tuesday to discuss climate change, and agreed in principle on a 20 per cent cut in CO₂ output by 2020, with a further 10 per cent if other industrialised nations join in. The UK, Spain and Slovenia had pushed for 30 per cent cuts. "This year could potentially be a tipping point in the fight against climate change," said UK environment minister David Miliband.

And time is running out. In April the Intergovernmental Panel on Climate Change will publish its assessment of how global warming will affect us, and a leaked chapter suggests the impact will be profound. It warns that glaciers in Greenland and West Antarctica are more likely to melt than previously thought, possibly raising sea levels by 4 to 6 metres in the coming centuries. In 2001 the IPCC said there was a very low probability of widespread melting of ice sheets, but the new report says there is a 50 per cent chance of this happening.

Genetic privacy

A LAW that would protect people in the US from being denied jobs or insurance because of their genetic make-up looks set to be passed after 12 years of debate.

The Genetic Information Nondiscrimination Act (GINA), introduced into Congress on 16 January, is sweeping through committees in the House of Representatives and is tipped to appear before the Senate and the full House within weeks. If passed, GINA will become the first federal law to prevent employers from

collecting genetic information on their employees. It would also outlaw genetic discrimination, preventing insurers from denying coverage or charging higher premiums based on a person's predisposition to disease.

Previous attempts to introduce such a law faltered in a Republican-dominated House, but that all changed when the Democrats took charge of Congress last November. "There's a willingness to get something passed," says Karen Rothenberg at the University of Maryland School of Law in Baltimore.

IT'S REALLY, REALLY BAD

You couldn't call it subtle. The International Atomic Energy Agency (IAEA) is adding a skull and crossbones and the figure of a person running away to its warning symbol for dangerous ionising radiation.

"Too many people get injured each year when they find a large source of radiation, don't understand the symbol and take off the lead shielding," says Carolyn MacKenzie of the IAEA. In recent incidents, people have died trying to

salvage cobalt sources from dumped medical equipment.

When the IAEA tested the original radiating "trefoil" symbol at an international school, it found that many children mistook the trefoil for a non-threatening propeller. So on 15 February it launched the new design, adding alarming images to the trefoil.

The IAEA tested it in 11 countries. "It means stop, run away," says MacKenzie. "Most people got the message."

"This year could potentially be a tipping point in the fight against climate change"

already 379 ppm. The post-Kyoto plan also advocates emissions targets for all countries, with tough targets for rich countries and softer ones for countries undergoing industrialisation. Other targets include developing energy-efficient technologies,

Citizen = suspect

MISCARRIAGES of justice could arise from the UK government's plan to use biometric ID card data to crack unsolved crimes, security experts warned this week.

On Monday prime minister Tony Blair said that one of the advantages of the planned ID cards is that police will be able to

"Now it seems the national ID system is to be a national suspect database"

compare fingerprint data from the ID card database with "the fingerprints found at the scene of some 900,000 unsolved crimes".

This makes everyone with a card a suspect, say critics. "We were told the national ID system would assure identity based on biometrics. Now it seems it's to be a national suspect database," says Ross Anderson, a computer security engineer at the University of Cambridge.

With fingerprint evidence proven unreliable in a number of high-profile miscarriages of justice (*New Scientist*, 17 September 2005, p 6) wrongful accusations are likely. "If the Home Office starts matching thousands of prints a week against a database of 60 million people, the number of misidentifications will become substantial," Anderson predicts.

The cards will be issued to British citizens from 2009.



Hey, I've become a new species

Noah's barcode

SIX new bat species and 15 new bird species have been discovered in the trial run of an ambitious plan to genetically "barcode" all life on Earth.

All the new species had previously been misclassified because they looked and sounded the same as other species. Only when the animals' DNA had been screened did it become clear that they belonged to distinct species.

Researchers scanned the DNA

because it is located in cells' energy-generating mitochondrial DNA rather than that of the nucleus, but mitochondrial DNA is also less likely to become scrambled. This makes it ideal for barcoding species, says Hebert (*New Scientist*, 26 June 2004, p 32).

The new species included *Platyrrhinus helleri*, a frog-eating bat (pictured). "That's my favourite," says Hebert.

Alien alert

AUSTRALIA'S astronomers are expecting an invasion from Mars. In a poll, fewer than half of respondents said they trust NASA to protect Earth from organisms brought here in Martian soil.

Sarah Joyce and colleagues at the University of Western Australia in Perth polled 74 people belonging to four Australian astronomical societies about a NASA mission that aims to return soil from Mars after 2020.

Only 36 of the astronomers had "complete confidence" that NASA would protect Earth from contamination – while 1 in 10 had no confidence at all. And more than a fifth do not believe that NASA will "honestly inform the public of the risks" of the mission (*Advances in Space Research*, DOI: 10.1016/j.asr.2007.02.009).

"NASA must realise the importance of international risk communication," says Joyce.

Ready to share flu again

Indonesia is to resume sending samples of H5N1 flu to foreign labs following discussions with the World Health Organization. The samples are vital for tracking the evolution of the virus, but Indonesia had stopped sending them in protest that it was unlikely to benefit from any resulting vaccine. The WHO has now promised to help Indonesia make its own vaccine.

Green alliance

More than 85 major companies and organisations, including insurance firm Allianz and General Electric, the world's second largest company, have signed a statement calling for governments to set targets for greenhouse gas emissions. The Global Roundtable on Climate Change statement was signed in New York on Tuesday.

No simple answers

Autism has multiple genetic origins rather than a single cause, according to the most extensive genetic study of the brain disorder yet. Researchers who analysed DNA from 1168 families have identified two new areas involved, including a region of chromosome 11 and a gene called *neurexin 1*, which plays a role in early brain development (*Nature Genetics*, DOI: 10.1038/ng1985).

Balls to the rescue?

Doubt has been cast on a plan to plug Indonesia's mud volcano with concrete balls. The authorities are already building towers to drop the 400-kilogram balls into the mouth of the Javan volcano that started erupting in May. However, James Mori at Kyoto University in Japan warns that they may be too small to stop the flow.

Milk hormone may fight MS

A hormone that stimulates lactation in women shows promise as a treatment for multiple sclerosis. Pregnant and non-pregnant mice given prolactin generated twice as many cells that produce myelin – the nerve protein that is depleted in MS – as control mice (*Journal of Neuroscience*, vol 27, p 1812).



Get the message?

Special report Sex offenders

THROWING AWAY

Across the US thousands of ex-cons who have served jail time for sexual offences are kept incarcerated on questionable grounds

PETER ALDHOUS, SAN FRANCISCO

FEW hearts bleed for Emory Michau Jr. Now 60, Michau was jailed in 1993 for molesting an 8-year-old boy. After serving his sentence, he solicited sex from a 17-year-old youth and was jailed once more. By 2003, after a further two years inside, he was scheduled for release. Yet Michau remains incarcerated in Charleston county jail, South Carolina. Not for his previous crimes, but because he has refused to undergo psychiatric assessment to determine whether he poses a danger to the public. If the assessment went against him, Michau could be locked up indefinitely in a secure mental facility.

His case highlights a growing controversy surrounding the US justice system. Thousands of sexual offenders who have already served their jail terms are kept incarcerated in mental institutions, and some psychiatrists and legal commentators say there are major inadequacies in the assessment methods that put them there. On top of its implications for the civil liberties of the people who would otherwise have been released, the practice is estimated to cost more than a quarter of a billion dollars a year to implement and does little to reduce levels of sexual abuse or rape in society.

In many countries, public revulsion

towards sex offenders – particularly those who abuse children – has led to harsher sentencing. Since April 2005, judges in England and Wales have been able to impose indeterminate sentences on dangerous convicted criminals, including some sex offenders. Similar provisions exist under Canadian law. In the Australian state of Queensland, sex offenders can be imprisoned indefinitely, subject to an assessment made after they have served some time in jail.

The US is different in that some sex offenders are first dealt with as criminals, but after serving their time in prison are turned over for indefinite “civil commitment” on the grounds that they are suffering from a mental illness that makes them dangerous to the public. In January, New Hampshire became the 18th US state to implement civil commitment for sex offenders who are deemed to be dangerous, and others are debating whether they should follow suit.

By May 2006, 3646 individuals were being held in the US under these laws, according to the most recent survey, conducted by Adam Deming of the Indiana Sex Offender Management and Monitoring Program in Indianapolis. Of these, 2627 had been committed as dangerous sexual predators, while the other 1019 were waiting for their evaluations to be completed

After completing their sentence, offenders diagnosed as mentally ill can be held indefinitely in a secure facility



THE KEY

A photograph of a person in a dark uniform with 'DCSO' on the back, walking away from the camera down a long, dimly lit prison corridor. The corridor has rows of cell doors on both sides, and a bright light source is visible at the far end.

(see Map, page 8). Few can expect to be released any time soon. Just 427 of 3493 offenders detained since 1990 had been released by 2004, according to a survey by Roxanne Lieb of the Washington State Institute for Public Policy in Olympia.

While the details of civil commitment laws vary from state to state, the US Supreme Court has ruled that civil commitment can be applied only to convicted sex criminals who have a mental disorder that makes them likely to commit further sexually violent acts. This is where the problems begin, as many sex offenders do not easily fit any of the categories defined in the psychiatrists' bible, the *Diagnostic and Statistical Manual of Mental Disorders* or *DSM*, published by the American Psychiatric Association.

The *DSM* lists a range of what are known as paraphilias: intense sexually arousing fantasies, sexual urges or behaviours that recur over a period of at least six months. Sexual sadism and paedophilia fall under this heading, yet only a small minority of rapists have sadistic fantasies, and even persistent child abusers may not be sufficiently fixated on sex with children to qualify as paedophiles, according to a strict interpretation of the *DSM*.

Some observers, including Lieb, argue the fault lies with the *DSM* for providing too narrow a

"Some offenders are being shoehorned into diagnoses that do not apply"

Special report Sex offenders

definition of paraphilia. Critics of civil commitment argue that some offenders are being shoehorned into diagnoses that do not apply, to satisfy the Supreme Court's requirement to allow them to be detained.

Psychiatrists stress that being a sexual offender does not necessarily make you mentally ill according to any recognised criteria. Michael First, a psychiatrist at Columbia University in New York and an adviser on the *DSM*, argues that diagnoses made for the purpose of civil commitment proceedings often confuse persistent criminal behaviour with mental illness. "The behaviour itself is not enough to make the diagnosis," he says.

Of 2082 diagnoses recorded by Deming in his survey, 1135 detainees had been marked down as paedophiles, while 692 were evaluated as belonging to the catch-all category of "paraphilia (not otherwise specified)". Six states failed to provide Deming with the particular paraphilia diagnoses used to detain offenders.

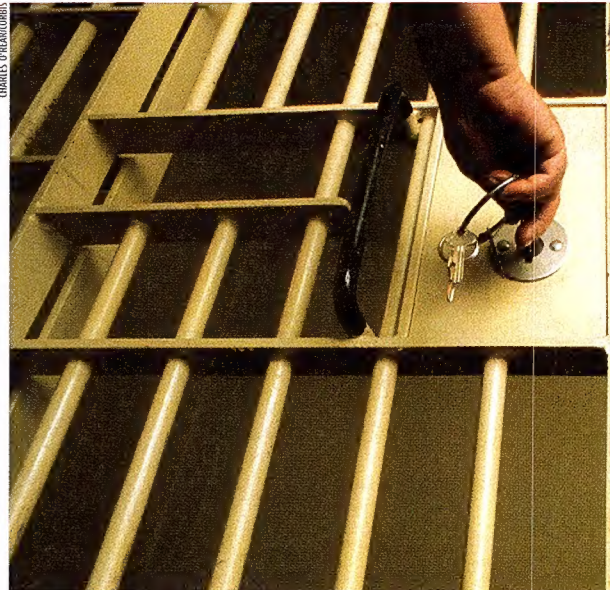
Eric Janus of the William Mitchell College of Law in St Paul, Minnesota, claims that diagnoses are open to manipulation. He has studied men detained under Minnesota's civil commitment laws. Just 25 per cent of those committed in 1993 were diagnosed with a paraphilia, but by 1996 the figure for newly committed men was more than 90 per cent. By 2001, 97 per cent of all men held under

civil commitment in Minnesota were judged to be paraphilic, including a substantial proportion who were not given this diagnosis when they were first detained.

These are not the only questions being raised about the consistency of diagnoses. Jill Levenson, who studies criminal justice policy at Lynn University in Boca Raton, Florida, compared the diagnoses made by different professional psychiatric evaluators for nearly 300 offenders assessed under that state's civil commitment law. In general, she was encouraged by the level of agreement. In 85 per cent of cases, two evaluators agreed on whether or not an offender was a paedophile. When it came to a diagnosis of "paraphilia (not otherwise specified)", however, her survey revealed the level of agreement fell to 68 per cent.

"No one is quite sure what counts as a mental disorder," Janus argues. If no one can be sure of that, how can courts rely on psychiatric diagnoses to incarcerate offenders who have served their sentence?

The second major flaw in the system relates to the methods used to assess the likelihood that a particular individual will reoffend if released. Here, evaluators rely heavily on actuarial risk assessments. Conceptually, these are similar to the statistical tools used to calculate a person's car insurance premiums given the crime rate in their neighbourhood,



People released from jail account for only a minority of sex offences

the extent of their driving experience, and so on. The tools used to assess sex offenders consider factors such as the extent of their prior offending, the sex of their victims, and whether these victims were strangers. They are derived using information about a sample of known sex offenders, and subsequently validated by analysing their predictive value when applied to other offenders after their release.

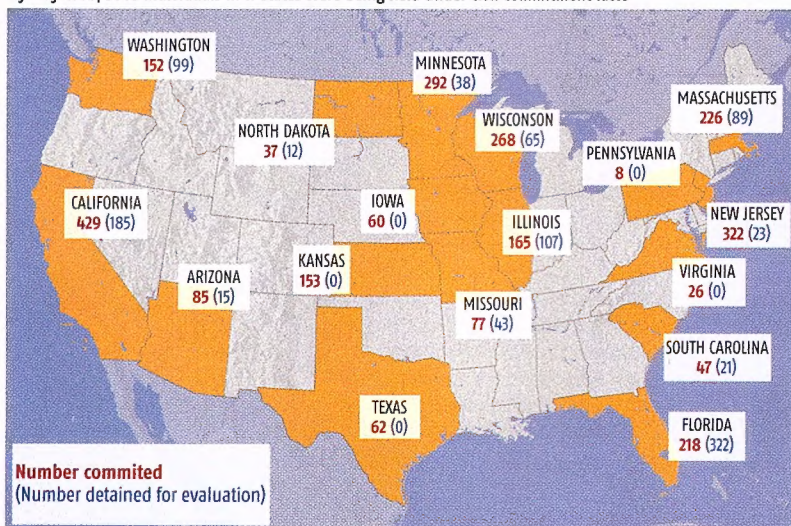
Research into the value of these tools involves some arcane statistics (see "Powers of prediction"). However, the findings are simple enough: the tools are better than expert clinicians at predicting whether a sexual offender will reoffend.

That doesn't mean they always get it right. According to Karl Hanson of Public Safety and Emergency Preparedness Canada in Ottawa, who is a co-author of Static-99, the assessment tool most commonly used in US civil commitment proceedings, the best that risk-assessment tools can achieve is to identify a high-risk group – encompassing between 10 and 15 per cent of all sex offenders – who have about a 60 per cent chance of being reconvicted within 15 years of release. Using such tools to commit these "high-risk" offenders would therefore mean that 40 per cent of those kept locked up would not have been reconvicted within 15 years had they been released instead.

In practice, civil commitment

CIVIL COMMITMENT IN THE US

By May 2006, 3646 individuals in 17 states were being held under civil commitment laws



SOURCE: INDIANA SEX OFFENDER MANAGEMENT & MONITORING PROGRAM, 2006



"These laws have been developed with more concern for public protection than civil liberties"

proceedings are even less likely to accurately predict reoffending, according to Raymond Knight, a psychologist at Brandeis University in Waltham, Massachusetts. In the hearings, risk assessments are typically adjusted to account for other factors deemed relevant by professional evaluators, including aspects of an offender's psychiatric profile. "Clinicians are very bad at weighting new information and adding it to an actuarial assessment," Knight says. Even allowing for the fact that reconviction rates underestimate

offending – because many sex crimes go unreported or their perpetrators aren't found – the evidence suggests that a substantial minority of those held under civil commitment would not reoffend if released. "Are assessment tools accurate enough to take away people's liberty prospectively? My answer would be no," Janus concludes.

Most states' civil commitment laws have been worded to sidestep such objections, and require only that those detained are more likely to reoffend than not. Some set the bar even lower. "These laws have been developed with more concern for public protection than civil liberties," says Cynthia Calkins Mercado, a clinical psychologist at the John Jay School of Criminal Justice in New York.

So do these laws protect the public? Statistics on sex crimes suggest they do not to any great extent.

The US Bureau of Justice Statistics has studied offending patterns for a cohort of more than 270,000 prisoners released in 1994 across 15 states. Given that most states had not then enacted civil commitment laws, the sex offenders in that group are likely to include individuals who today would be detained as dangerous sexual predators.

Sex offenders accounted for about 4 per cent of those released, and over three years of follow-up these individuals were on average about four

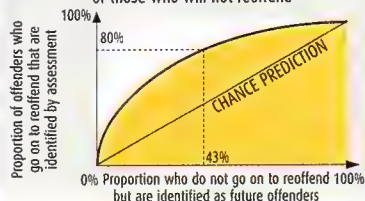
times as likely to be arrested for a subsequent sex offence as those previously jailed for other crimes. Yet because there were fewer of them, the sex offenders still accounted for only a minority of the sex crimes committed by the group as a whole: of the ex-cons subsequently arrested for sexual offences, 87 per cent had previously been imprisoned for some other type of crime.

What's more, analyses by the Bureau of Justice Statistics of felonies in large urban counties across the US shows that most sex crimes are committed by people who have never been convicted of any crime. The latest available figures, from 2002, reveal that 79 per cent of those charged with rape had no prior felony convictions. Evidence from various jurisdictions similarly suggests that most convicted child abusers had also not previously been in trouble with the law.

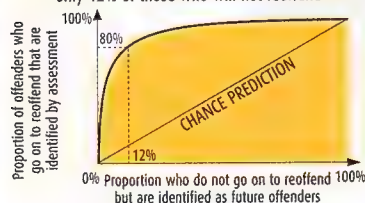
To critics of current policies, the mismatch between public perceptions and crime statistics is at the root of the problem. People are appalled by sex offending, but do not like to acknowledge that it is widespread throughout society. So the public and media demonise convicted offenders, and politicians devise laws such as civil commitment in response. "It's a way of articulating society's condemnation of sexual violence without doing anything fundamental about it," says Janus. ●

MARGIN OF ERROR

When this assessment tool identifies 80% of those who will reoffend, it will also falsely identify 43% of those who will not reoffend



A better assessment tool will identify 80% of those who will reoffend, while falsely identifying only 12% of those who will not reoffend



POWERS OF PREDICTION

To judge the tools used to assess the danger posed by sex offenders, statisticians rely on what is known as the receiver operating characteristic (ROC) curve – most famously used to investigate the performance of US radar following the Japanese attack on Pearl Harbor.

ROC curves plot the proportion of false positives (in this case, offenders identified as high risk who do not offend again) on the horizontal axis against the proportion of true positives (similar "high-risk" offenders who do reoffend) on the vertical axis.

Just guessing should give a straight line, while progressively better prediction tools move the curve

towards the top left (see Graphs). These plots can be summarised by calculating the proportion of the area of the graph under the curve: 0.5 for random guesses; 1.0 for a perfect prediction, which would give a single point in the top left corner.

In a new unpublished study conducted for the US National Institute of Justice, psychologists Raymond Knight of Brandeis University in Waltham, Massachusetts, and David Thornton of the Sand Ridge Secure Treatment Center in Mauston, Wisconsin, have tested the leading actuarial risk assessments using information on a sample of sex

offenders treated at a secure centre in Massachusetts between 1959 and 1984. Looking at sex offences committed in the first three years after release, the areas under the curves varied between 0.67 and 0.70 – apparently not a bad result.

But if you consider what's called the predictive area – the total area between a straight line representing a prediction based on chance, and perfect prediction based on a single point in the top left corner – then things look less good.

"We're explaining less than 40 per cent of the predictive area," says Knight. "When I explain that, most people are horrified."



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Aus Liebe zum Automobil



US mobilises for a biofuelled future

IVAN SEMENIUK, SAN FRANCISCO

THE tree was a black cottonwood and it grew by the banks of the Nisqually river in Washington State. The tree is gone now, swept away by the shifting river, but not before Gerald Tuskan of Oak Ridge National Laboratory in Tennessee and his team made history last year by sequencing its genome – a first for any tree species.

While the feat may seem like an odd achievement for a lab that was originally created for the Manhattan Project – the American-led effort to develop an atom bomb – it is somehow fitting. Like the bomb, the tree is meant to help the US gain strategic leverage, though this time through energy independence.

“The big push is to displace imported oil,” says Tuskan. “The question is, can we produce ethanol cheaply enough to do that.” By tinkering with the black cottonwood’s genome, researchers have already produced variants with thicker stems and shallower root systems in the hope of engineering a more harvestable form of

biomass for conversion to ethanol. The approach even resembles that of the Manhattan Project in that it embraces the revolutionary advances in the science of its era: physics then and biotechnology now.

Ethanol has long been touted in the US as an environmentally friendly alternative to petroleum. In practice, however, it has proved to be anything but. The reason is that in the US ethanol for fuel is currently produced from corn – a crop that requires intensive farming, chemical fertilisers and plenty of water. Critics argue that growing corn for ethanol simply trades one environmental crisis for another while driving up the price of an international staple.

To escape the problem, says Nobel laureate Stephen Chu, director of the Lawrence Berkeley National Laboratory (LBL) in California, ethanol producers must forgo the easily fermented

“The potential yield that we have from converting cellulose to biofuel could be five or 10 times greater than that of corn”

sugar and starch in corn and switch to plants that can be harvested for cellulose. “The potential yield that we have from converting cellulose to biofuel could be five or 10 times greater than what we have for corn,” says Chu. Depending on the conditions, the ideal cellulose-rich crop would be a variant of a swift-growing tree such as the cottonwood, or a tall grass such as those of the genus *Miscanthus*.

To facilitate the efficient breakdown of cellulose, Melvin Simon of the California Institute of Technology in Pasadena has been studying how termites do it so well. Working with the US Department of Energy’s Joint Genome Institute in Walnut Creek, California, Simon has sequenced the genes of bacteria that live in the termite’s gut and has now uncovered genetic instructions for creating wood-dissolving enzymes that he thinks could be optimised for biofuel production. “Microbes have had a billion years to try every means of energy conversion,” says Simon. “We have barely touched the potential in that diversity.”

This new ferment across the spectrum of biofuel research was apparent in discussions at this week’s meeting of the American Association for the Advancement of Science in San Francisco. ●

THIS WEEK 50 YEARS AGO

The difficult birth of e-banking

Banking is one of those industries that might have been invented for the purpose of demonstrating what electronics can do for bookkeeping, but it has taken banks an unforgivably long time to realise it. It was only last year that a group of the big banks persuaded their more conservative colleagues to set up a committee to investigate how electronics could cut down the vast amount of clerical labour in the banking system.

The committee has now reported that it is technically possible to introduce electronics from top to bottom of the banking system, but the reception has been mixed. Two of the biggest banks seem keen to try out such a system, but at least one regards it as so much science fiction.

This is a serious split, for the banks depend on cooperation between each other. If one bank refused to join a system of electronic bookkeeping, its value to the others would be seriously reduced. However, no decisions will be taken until electronics manufacturers respond to the committee’s proposals for the necessary equipment.

The cheque is the cornerstone of the committee’s plans. Across it would be printed a variety of codes and figures. Two types of machinery would then be needed. One is the sorting equipment, fitted with code readers, to divide the cheques up into the bank branches to which they have to be sent. The other type consists of a computer and ancillary input and output devices that can take a cheque, decide which account it belongs to and produce a permanent record of the transaction.

Perhaps, now that the committee has reported, the banks will be needed into realising they could respond with similar vigour and imagination. Otherwise it seems they are blandly asking electronics manufacturers to spend considerable sums designing a banking system that they then may not choose to use.

From *The New Scientist*,
28 February 1957

INSIGHT

The grim aftermath of torture they don't bother to show you

THE media loves to consume itself. And so it was last week, after *The New Yorker* revealed that US military officials had met with producers of the hit TV show 24 to protest about its portrayal of torture. Commentators mused on the accuracy of scenes in which terrorists break and provide key information after just a few minutes of physical interrogation.

If only the medical aftermath of torture could attract similar attention. Torture is critically understudied, says Tom Campbell, who is studying for a doctorate in clinical psychology at Virginia Commonwealth University in Richmond. He became interested in the issue in 2004, after treating a torture survivor from Liberia. "I found there was

nothing really good in the literature on how to treat and even diagnose what I was seeing," he explains.

Yet in 2005, systematic torture occurred in 104 of 150 nations surveyed by Amnesty International, and this epidemic of suffering shows no sign of abating. There are millions of torture survivors across the globe, many of them refugees – perhaps 500,000 in the US alone. Campbell has now completed a review of scientific knowledge on the diagnosis and treatment of torture, to appear in *Clinical Psychology Review*.

Doctors are starting to understand the

Producers of US drama show 24 say they will cut the number of torture scenes

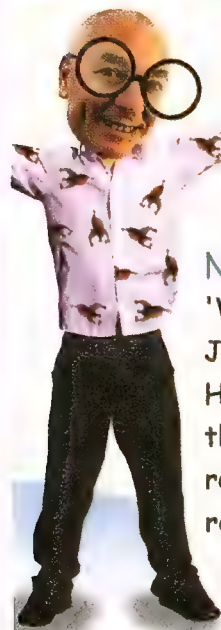
problems that persist after obvious wounds have healed, and those who specialise in treating victims are also finding that the physical and psychiatric consequences are intertwined.

For instance, post-traumatic stress disorder seems to be worse in individuals who have been beaten around the head, and may be linked to physical brain damage and cognitive impairment.



Such information is vital in giving survivors appropriate treatment, says Richard Mollica, who heads the Harvard Program in Refugee Trauma. One key question, Campbell says, is determining what forms of treatments work for which groups of torture survivors, classified according to their symptoms, cultural background, and so on. Mollica agrees that there is a pressing need for more research. "But it's impossible to get funding," he says.

Torture victims often do not mention their traumatic experiences when showing up for medical treatment. Mollica urges doctors to confront the issue, and ask refugees whether they have been tortured. The good news is that survivors can bounce back. "People are extremely resilient," Mollica says. But doctors often avoid asking about torture, for fear of opening a Pandora's box. **Peter Aldhous** ●



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Back-up circulation kicks in after stroke

MICHAEL REILLY

A STROKE can happen seemingly without warning. As blood clots block circulation to large portions of the brain, tissue begins to die and you can lose your senses, motor skills and memories.

Fortunately, our brains don't give up without a fight. An emergency back-up system kicks in, opening dormant bridges between blocked arteries and healthy ones that normally supply different areas of the brain. This enables blood to flow around the blockage, resupplying

starved brain tissue with oxygen and glucose (see Diagram).

Doctors have known about this "collateral" system for decades, but precisely how it works, and why some stroke patients seem to have better collateral circulation than others, is still a mystery.

Now a small but growing group of scientists believe that better understanding collateral circulation could hold the key to unlocking new stroke treatments.

Most stroke research focuses on developing surgical devices that pry out clots, or on "clot-busting" drugs that dissolve

blockages, but David Liebeskind of the University of California at Los Angeles believes that the ability of collateral circulation to quickly restore blood flow to oxygen-starved areas of the brain makes it critical to reducing stroke damage. "Collaterals may even be more important to patient recovery than whether the blocked artery is reopened," says Liebeskind.

In a preliminary study of 62 people who had a type of stroke called persistent arterial occlusion, Liebeskind found that the death rate for patients with naturally good collateral circulation was 41 per cent, versus

65 per cent for patients with poor collateral circulation. They also recovered better – about a third of those with good collateral circulation escaped with moderate to light disabilities compared with just 7 per cent of those with poor collateral circulation. "We've seen the most dramatic shift towards good recoveries I think than anything I've seen," says Liebeskind, who presented his results at the International Stroke Conference in San Francisco earlier this month.

Researchers are now looking at ways of manipulating collateral circulation to quickly restore the blood supply to areas of the brain damaged by a stroke. One device in clinical trials at 40 US hospitals is an experimental catheter called NeuroFlo, which sits in the aorta, the main blood vessel supplying

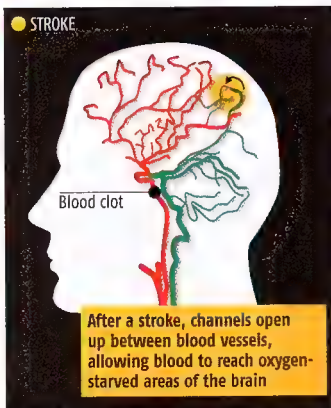
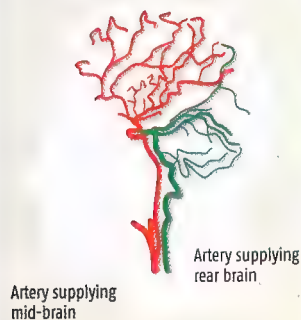
"Collateral circulation may be even more important to patient recovery than whether the blocked artery is reopened"

They're



DAMAGE LIMITATION

● NORMAL



the lower half of the body. Inflating its balloons enhances collateral circulation in the brain by reducing blood flow to the legs.

In a pilot study of 29 patients who had experienced a stroke less than 10 hours beforehand "about

60 per cent had significant neurological improvement, at least for the 24 hours after the device was used", says Rick Schallhorn, vice-president of marketing for CoAxia, the company that produces NeuroFlo.

Despite these advances, the arteries involved in collateral flow display a number of traits that researchers still don't fully understand. They've found that vessels diverting blood flow are able to grow in size so they can accommodate more blood and make the system more robust, but the flow remains highly sensitive to changes in blood pressure, and can collapse without warning.

"Collaterals can go for a while then go bad. We don't know why exactly," says Max Wintermark of the University of California, San Francisco.

It is also not clear why collateral circulation seems to be dormant except after strokes, and why it is not more extensive in the first place, which would allow the constant exchange of blood between the different arteries that supply the brain. "One thing you

"Vessels diverting blood flow are able to grow in size so they can accommodate more blood and make the system more robust"

would think is if the body was smarter, you'd have larger [bridges]," Liebeskind says.

To try and solve these mysteries, Liebeskind is now working with William Dillon of the University of California, San Francisco, to combine modified brain imaging techniques to measure collateral flow in near real time.

Despite the apparent importance of collaterals in minimising stroke damage, Liebeskind says the field is still in its infancy. "If you open up a textbook on stroke, you won't find anything on collaterals – it's a whole missing chapter," he says. ●

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In brief



While you slumber, your brain is putting the world in order

EVER wondered why sleeping on a problem works? It seems that as well as strengthening our memories, sleep also helps us to extract themes and rules from the masses of information we soak up during the day.

Bob Stickgold from Harvard Medical School and his colleagues found that people were better able to recall lists of related words after a night's sleep than after the same time spent awake during the day. They also found it easier to recollect themes that the words had in common – forgetting around 25 per cent more themes after a waking

rest. "We're not just stabilising memories during sleep," says Stickgold. "We're extracting the meaning."

In another experiment, people were shown cards with symbols followed by reports of various weather outcomes – so for example, diamond shapes might be followed by rain 70 per cent of the time. Twelve hours after training, people felt able to guess the weather from the symbols, though they struggled to voice their "rules". After sleeping, their predictions were 10 per cent better.

Sleep helps us extract rules from our experiences, says Stickgold. It's like knowing the difference between dogs and cats, he says, even if it is hard to explain. He presented the results last week at a meeting organised by The Science Network at the Salk Institute in La Jolla, California.

It pays to be well hung, if you're a rat

WELL-HUNG males may enjoy an evolutionary advantage over their less well-endowed competitors – in certain rodents, anyway. The finding may help answer the vexing question of why penis size is so variable among mammals.

Steven Ramm, an evolutionary biologist at the University of Liverpool, UK, gathered published measurements of the length of the penis bone in four orders of

mammals: rodents, primates, bats and carnivores, then corrected for the fact that related species tend to have similar-sized penises. He compared these adjusted lengths with body weight and testis size, which is a good indicator of a species' promiscuity and so of the amount of competition a male will face for fertilisation.

Rodents with relatively large testes also tended to have

relatively long penises, Ramm found (*The American Naturalist*, vol 169, p 360). The advantage this confers on rodents is unknown, but a generously proportioned organ may deposit a male's sperm further up the female reproductive tract, giving them a head start in the race to the egg, Ramm speculates.

A similar, but weaker pattern occurs for carnivores. However, Ramm found no evidence that the correlation exists in either bats or primates.

Milky Way away

GOODBYE Milky Way. Every galaxy is destined to slowly disintegrate as the dark matter that binds it together vanishes.

So predict Lawrence Krauss and Glenn Starkman at Case Western Reserve University in Cleveland, Ohio, who have studied a class of weakly interacting massive particles (WIMPs) that are prime candidates for dark matter.

These WIMPs are their own antiparticle, and most are thought to have annihilated each other in the very early universe. As the universe cooled and expanded, surviving WIMPs spread apart, making collisions rare. But in the cores of galaxies, dark matter is dense enough for many collisions to occur, say Krauss and Starkman. As a result, this dark matter will vanish and galaxies will slowly unravel (www.arxiv.org/astro-ph/0702333).

Luckily the process won't begin in earnest until the universe is 10^{10} times the age it is now.

The crush that's good for the heart

VAMPIRES look away now.

To get the best health benefits from garlic, crush it and let it stand for 10 minutes, then eat it raw or cook it for less than 6 minutes.

The crushing breaks open cell membranes to release alliinase, an enzyme vital for creating anti-clotting compounds, the most active being alliin and thiosulphinates. In uncrushed garlic the alliinase remains locked away.

Further experiments led by Claudio Galmarini of INTA-EEA, a food consultancy in Mendoza, Argentina, showed that leaving the garlic to stand allows time for the alliinase to get to work creating the blood-thinning compounds, while overcooking destroys the enzyme (*Journal of Agricultural and Food Chemistry*, vol 55, p 1280).

No more gaps with home-grown teeth

HERE'S something to smile about: replacement teeth have been grown from scratch and implanted into the mouths of adult mice. A similar technique might one day replace missing teeth in humans.

Takashi Tsuji at the Tokyo University of Science in Japan and his colleagues extracted single tooth mesenchymal and epithelial cells – the two cell types that develop into a tooth – from mouse embryos. They persuaded these cells to multiply and injected them into a drop of collagen gel. Within days, the cells formed tooth buds, the early stage of normal tooth formation.

The team extracted teeth from adult mice and transplanted the tooth buds into the cavities, where they developed into teeth with a normal structure and composition. The engineered teeth also developed a healthy blood supply and nerve connections (*Nature Methods*, DOI: 10.1038/NMETH1012).

Other researchers have previously grown intact teeth from engineered tooth buds implanted in the kidneys of mice. They stopped short of showing that engineered buds could develop into teeth in the jaw (*New Scientist*, 26 June 2004, p 13).

The cells in Tsuji's study were taken from embryos, meaning the technique would be difficult apply to humans for now. His team is now planning to look for adult cells, such as epithelial or mesenchymal stem cells, that could be used instead.

ROGER MESSING/ISTOCK/GETTY



IVF babies draw short straw on birth defects

BABIES conceived using assisted reproductive technologies (ART) really do seem to be at higher risk of birth defects – though doctors don't yet know why.

In the latest study, researchers analysed the health records of 61,208 deliveries in Ontario, Canada, during 2005. They found that the 1394 babies born via ART – IVF, ovulation induction and intra-uterine insemination – were about 60 per cent more likely to have birth defects than children conceived naturally. Gastrointestinal

abnormalities were most common, though the babies also had a higher risk of bone, muscle and heart-related defects.

It is important to put the results into perspective, says Darine El-Chaar at the University of Ottawa, who led the study, since the absolute risk of birth defects was still relatively low, affecting just 2.62 per cent of ART babies, compared to 1.87 per cent of naturally conceived babies.

However, scientists are still struggling explain why the difference exists at all. Some

point to the drugs prospective mothers take to induce ovulation, while others blame an as-yet-unidentified aspect of a couple's infertility.

Alternatively, spending three days in a Petri dish could disrupt DNA imprinting, which controls how genes are expressed, suggests Richard Paulsen at the University of Southern California in Los Angeles.

The research was presented at a meeting of the Society for Maternal-Fetal Medicine in San Francisco this month.

Birds of prey are a pollution magnet

CHINA'S birds of prey are carrying an unexpected cargo: record-breaking amounts of flame retardant, which seems to be accumulating in animals to a much greater degree than anyone thought.

PBDE or polybrominated diphenyl ether, commonly used in textiles, plastics and electronics, is a ubiquitous environmental pollutant. One formulation, called Deca on account of the 10 bromine atoms it has, is the most widely used because no one thought it built up in animals.

Now researchers at the Virginia Institute of Marine Sciences in Gloucester Point have found very high levels of Deca in predatory birds collected near Beijing. Kestrels had the highest amount, with one specimen containing more than 12,000 nanograms per gram of tissue, by far the highest amount ever found in an animal. Buzzards, sparrowhawks and owls were also affected (*Environmental Science & Technology*, DOI: 10.1021/es062045r).

Deca's toxicity is unknown but it can break down in animals into chemicals similar to the toxic Penta and Octa formulations.



Jays travel in time to be sure of breakfast

WE'RE all time travellers, in the sense that we can recall memories and plan for the future. Mental time travel is considered by many to be unique to humans; animals were assumed to be "stuck in time", but now that idea has been challenged... by a bird.

Western scrub jays (*Aphelocoma californica*) store food in caches, but as with other provisioning animals, such as squirrels, it is difficult to tell whether they do so because they are planning for the future or because they are behaving instinctively, as they do when building a nest or migrating. Also they could simply be hungry.

To see if they had a sense of the future, Nicola Clayton and colleagues at the University of Cambridge allowed eight jays to feed during the day for six days, except in the morning, when they were allowed to enter either a compartment where they got breakfast or one where they didn't. On the evening of day 7 the jays were unexpectedly given extra food, and the researchers found they stashed the surplus in the compartment where they had learned they would not get breakfast. This suggests that they do plan for the future – in this case a future without breakfast (*Nature*, DOI: 10.1038/nature05575).

"If I thought I'd end up in a grotty motel with no breakfast, I'd take provisions with me," says Clayton.

Who says 13 is an unlucky number?

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13 FACTS ABOUT 13

The 13th root is the most famous integer root calculation record, because 13 is the first prime number over 10 such as the last digit of a 13th integer power is the same as the last digit of its 13th root

The known universe is currently thought to be about 13.7 billion years old, with an error of about one percent

There are 13 zodiac constellations, which consist of the 12 signs in the astrological zodiac and Ophiuchus

The New General Catalogue object NGC 13 is a spiral galaxy in the Andromeda constellation

The expression "A year and a day" refers to 13 28-day lunar months plus 1 day

The number of cards in a single suit of a standard deck of playing cards

Unreasoned fear of the number 13 is termed triskaidekaphobia

In 13 A.D. Strabo published his view on the shape of the Earth

The number of dimensions in some theories of relativity

The number of loaves in a "baker's dozen"

The 13th moon of Jupiter is Elara

The atomic number of aluminium

There are 13 Archimedean solids



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NS070P01

Health checks, not shots

Blanket vaccination against a sexually transmitted virus is the wrong way to protect women's health, says **Ralph W. Moss**

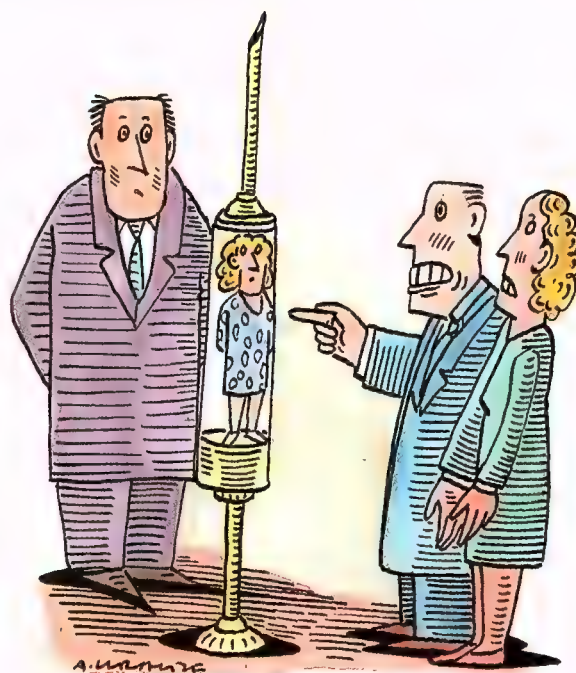
CHILDREN and vaccines can be a controversial combination when it comes to forming public policy. Where the vaccine concerned is designed to protect against a sexually transmitted infection, expect fireworks.

The Republican governor of Texas, Rick Perry, is feeling the heat from religious groups and concerned parents after signing an order on 2 February requiring 11 and 12-year-old Texas schoolgirls to be given a new vaccine called Gardasil. It protects against human papillomavirus (HPV) types 6 and 11, which cause cervical warts, and HPV 16 and 18, which cause two-thirds of cases of cervical cancer. At least 18 other states are considering similar action. Eventually, if supporters have their way, the entire female population of the US – around 150 million – will be compulsorily vaccinated.

Europe is likely to follow suit. The European Commission approved Gardasil in September 2006, following approval of the drug by the US Food and Drug Administration (FDA) in June. A special panel of the UK government's expert advisory body on vaccination is due to meet this month to consider proposals for a nationwide HPV vaccination programme for schoolchildren similar to that taking shape in Texas.

Many parents feel that a vaccine for sexually transmitted diseases interferes with the way they raise their children. Indeed, Gardasil seems an odd vaccine to choose as a requirement for school entry, since HPV is not spread by ordinary day-to-day contact. Issues of civil liberties and religious freedom aside, there are also serious clinical and policy questions over whether it should be administered to children in this way.

The first issue is safety. Is Gardasil really as safe and effective as Merck, its manufacturer, and the FDA claim? In a clinical trial of 11,000 individuals, the rate of immediate side effects was indeed low – about 1 per cent – but little



is known about its long-term effects. The health of the trial participants was monitored for no more than four years, and in the case of 11 to 12-year-olds, who are the most vulnerable group, for only 18 months. This will mean that the first groups of compulsorily vaccinated schoolgirls will in effect be a testing ground for the drug's long-term safety. Gardasil may be as safe as advertised, but we should not forget Merck's infamous anti-arthritis drug, Vioxx, which the company withdrew in September 2004 after a study found that long-term use doubled the risk of heart attacks and strokes.

The second question goes to the heart of healthcare policy. Is this the best way to spend scarce health dollars? Merck charges \$360 for a series of three Gardasil injections. Administering the injections will add 18 to 25 per cent to this cost. Nationwide, the cost of vaccinating American girls with Gardasil will amount to some \$800 million a year. What is the potential anti-cancer benefit? Each year on

average in the US, 11,150 women are diagnosed with cervical cancer and 3670 women die from it. If HPV 16 and HPV 18 cause two-thirds of the cases, we can calculate that Gardasil will prevent almost 7500 of them, saving around 1200 lives. This is an unequivocally desirable outcome, but at \$800 million per year the cost of saving each life will be over \$650,000. If the goal is to save lives, there are more cost-effective ways of doing so.

This is because cervical cancer deaths are almost entirely preventable. Women generally only die of cervical cancer because they have failed to get regular cervical smear or "Pap" tests, which are highly reliable in detecting precancerous lesions at an early, curable stage. A 2001 study found that 12 per cent of women aged 18 to 64 had not received any Pap screening within the previous three years. This is hardly surprising, as more than 20 million women lack health insurance and they are far less likely to have regular tests than those who do have insurance. Cervical cancer is two to three times as common among women of Mexican-American, Puerto Rican or Vietnamese heritage, who tend to be less well off, as it is among non-Hispanic white women.

The main beneficiaries envisaged for Gardasil will therefore be the children of the poor, but is it really the answer to their health problems? Surely these women would be far better served by being given access to a comprehensive national health programme that includes Pap tests on a prescribed basis, and that would also allow other diseases and conditions to be discovered and treated early. Implementing a compulsory vaccination scheme for cervical cancer merely distracts from the urgent need to implement such a system.

Rather than administer high-tech vaccines to pre-pubescent girls, it would make more sense to allocate the money this would cost taxpayers to increasing the provision of basic gynaecological services to the underprivileged. This may not be as attractive to the pharmaceutical companies, but it is a better way of caring for women in the US and elsewhere. ●

"It would be better to spend the money on basic gynaecological services to the underprivileged"

Ralph W. Moss is director of the online information service CancerDecisions.com

Opportunities at Monash

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Monash Centre for Synchrotron Science

Monash University, Melbourne, Australia

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Level A/Level B plus superannuation

Duration: Three-year appointment

Contact: Professor Rob Lewis, tel. +61 3 9905 3622
or email rob.lewis@sync.monash.edu.au

Applications: By mail addressed to Dr John McDougall, Associate Director, Monash Centre for Synchrotron Science, Monash University, Building 26, Clayton Victoria 3800, Australia or email john.mcdougall@sync.monash.edu.au by 16/03/2007.

Location: Clayton campus **Ref No:** A077560

Robotics Research Fellow

Monash Centre for Synchrotron Science and Protein Crystallography Unit

Monash University, Melbourne, Australia

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Level A/Level B plus superannuation

Duration: Three-year appointment

Contact: Professor Jamie Rossjohn, tel. +61 3 9905 2352
or email susan.reynolds@med.monash.edu.au

Applications: By mail addressed to Dr John McDougall, Associate Director, Monash Centre for Synchrotron Science, Monash University, Building 26, Clayton Victoria 3800, Australia or email john.mcdougall@sync.monash.edu.au by 16/03/2007.

Location: Clayton campus **Ref No:** A077557

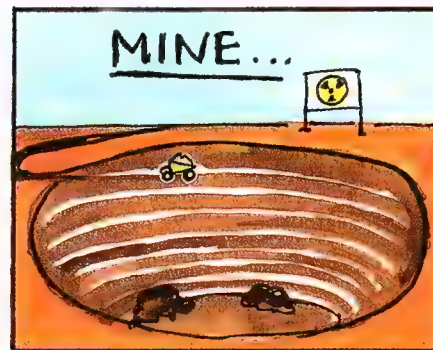
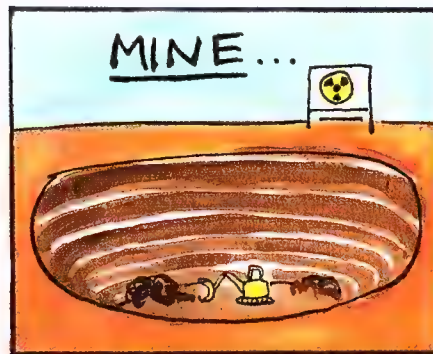
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Climate cause and effect

From Andrew Goldsworthy

I read with interest about what the IPCC "didn't tell us" about climate change (10 February, p 7). I was amazed by the illogicality of the sceptics who claim that a large part of global warming is due to changes in solar radiation. They seem to argue that if it were not entirely our fault, we wouldn't have to do very much about it.

Even if a large portion of warming is due to non-human causes, we will still be heading for disaster, and we are obliged to do whatever we can about it. Since we have no control over the sun's radiation, but can control our carbon dioxide emissions, we may still be able offset any change in the sun's radiation by reducing our atmospheric CO₂ level. All it means is that we must reduce it even more if we have to compensate for the sun's extra radiation as well.

People hoping to justify minimising any reduction in their CO₂ emissions by shifting some of the blame to the sun may have shot themselves in the foot.

They have made things worse for themselves, because their argument implies even more stringent targets.

London, UK

Conserving carbon

From G. Stecher

Ian Jackson asks about carbon dioxide emissions from bush fires (27 January, p 20). I estimate that the 2003 conflagration in Victoria, Australia, released around 88 million tonnes of CO₂ into the atmosphere in a few weeks. If we add to this 12 months' deficit in photosynthesis due to the denuded forests, the number increases to around 120 million tonnes of CO₂, or over twice the total CO₂ emission from all forms of transport for the whole of Australia for a year. The ledger is still open for 2006.

The sad truth is that if we stop the official hand-wringing and adopt timely interventions, a lot

of these fires could be stopped at their source.

Carboor, Victoria, Australia

From William Hughes-Games

Logging, if done correctly, could help defeat global warming. Pluck a mahogany tree out of the jungle and turn it into fine furniture or quality houses; every tonne of dry wood sequesters more than 1.5 tonnes of CO₂. Light reaching the floor of the jungle starts a race for survival between seedlings, so the new trees produce high-quality, knot-free timber. Everything depends on leaving the jungle or forest intact and selectively



removing trees here and there.

Clear-cutting doesn't produce the same quality second-growth timber. And, of course, a fully mature forest does not remove CO₂. It is carbon-neutral.

Waipara, New Zealand

The editor writes:

● Of course, very little timber harvested is currently made into "fine furniture". There's the matter of timing, too: on a century timescale, growing and still-standing trees are a carbon sink. Equally, while a bush fire may be carbon-neutral on a timescale that includes the vegetation regrowing, it produces a surge of CO₂ now.

Personal trauma

From Tom Anderson

In considering post-traumatic stress disorder (PTSD), it seems to me to be questionable to compare the traumatic impact of events such as rape, physical attacks or

distressing tours of duty against events like large-scale terrorist attacks or natural disasters (3 February, p 40). The attacks on 11 September 2001 and the 2004 Asian tsunami have reverberated in the affected societies' consciousness for years after the event, with wide media coverage. The people affected will have exchanged thoughts and feelings. Both these features would surely reduce the prevalence of PTSD.

In contrast, after events that affect people on their own or in small groups there is less opportunity for communication of feelings. There is no exposure to the incident after it has happened, and the potential for feelings of isolation is greater.

Perhaps the disparities observed in the percentages of people who develop PTSD after traumatic events are, in part, due to the natures of the events.

London, UK

From Pam Lunn

Towards the end of her article on post-trauma mental health issues Laura Spinney draws attention to the differing patterns of response between, say, 11 September 2001 or the London bombings of July 2005, and hurricane Katrina.

An attack in a public place is limited in time and space. The survivors go home, specifically to their own home, as well as to wider familiar neighbourhoods and networks.

Large-scale natural disasters, such as Katrina, are extensive in both time and space. There is no home to return to. There are no familiar neighbourhoods or networks to return to – these are precisely what has been destroyed. There is no "normality" into which the victims can reinsert themselves. Kenilworth, Warwickshire, UK

Wait for clinical trials

From Mike Martin

Ralph Moss of cancerdecisions.com states that dichloroacetate (DCA) has "never been tested in

humans, only in cell lines and experimental animals" (3 February, p 20). But according to *Environmental Health Perspectives* (vol 106, supplement 4) "DCA toxicity is predicated mainly on data obtained in inbred rodent strains administered DCA at doses thousands of times higher than those to which humans are usually exposed. In these animals, chronic administration of DCA induces hepatotoxicity and neoplasia. Ironically, the DCA doses used in animal toxicology experiments are very similar to those used clinically for the chronic or acute treatment of several acquired or hereditary metabolic or cardiovascular diseases. As a medicinal, DCA is generally well tolerated... It remains to be determined whether important differences in its metabolism and toxicology exist in humans between environmentally and clinically relevant doses."

I think we have to wait for clinical trials of DCA in people with cancer and not exaggerate a possible negative outcome beforehand. London, UK

Controlling hedgehogs

From Pat Morris

Hugh Warwick is right to feel annoyed that Scottish Natural Heritage ignored his own studies of translocated hedgehogs when advocating a cull of the population in the Hebrides (10 February, p 16). SNH also ignored several of my own published papers showing that translocated animals can cope well and do not suffer "slow and lingering deaths".

An exemplary eradication of a mammal population was carried out in the 1980s, when coypu were removed from the UK. That operation was managed according to a population model that predicted the trapping effort needed to achieve likely end dates.

The SNH operation is not science-based but conducted on a

- Dichloroacetate and cancer
- Fires, forests and climate
- No time riots ● Repair liability

"suck it and see" basis, a methodology that conservation managers should have left behind long ago. Clearly, eradication is not feasible with the present catching effort and will become even more difficult as numbers decline. Yet SNH has refused to



reconsider its actions and has already spent £90,000 in one year on this cull, killing just 66 hedgehogs. It has no projected end date. This is public money spent doing what the public clearly do not want – killing hedgehogs that could be released alive somewhere else.
Ascot, Berkshire, UK

Supersize, no surprise

From Peter Janiszewski
Certain participants in the Swedish overfeeding study showed apparent resistance to becoming "supersized" despite excess food intake (27 January, p 28). This should be no surprise. A number of experiments with pairs of identical twins have reported that twins gain almost exactly as much weight as each other, though there are marked differences between pairs of twins. This suggests that genetics play a large role in determining responses to chronic overfeeding. The same variability is seen in responses to weight-loss interventions through diet and/or exercise. Clearly, not every person who consumes excess calories will become obese, and conversely not every overweight person who diets and exercises will experience identical weight loss.

It seems that during past times of food scarcity, "thrifty genes" ensured survival. Unfortunately, these same genes now contribute to the development of obesity in our current "obesogenic" environment.
Kingston, Ontario, Canada

Brains aren't that simple

From John Anderson
Douglas Fox in writing about "the mind chip" perpetrates the sort of hype that exists in artificial intelligence (AI) research (3 February, p 28). As a neuroscientist, I applaud Kwabena Boahen's aim of understanding the brain – but to me the approach seems rather misguided.

It assumes that computation in the brain is supported only by chemical synaptic communication between neurons. This doctrine dominates both neuroscience and AI. It is now apparent, however, that cells of the glia – often thought of as the connective tissue of the nervous system – such as astrocytes also have roles in computation. Although we are still in the process of understanding how this works in concert with neuronal networks, the majority of AI research ignores it.

The ways in which glial cells signal (both with each other and with neurons) require different mechanisms from that of neuronal-neuronal communication. This fact is also ignored. There are also many coordinated structural changes that occur with both neuronal dendritic and glial processes that mediate complex communication.
Cardiff, UK

Who says we're unique?

From Paul Kail
Adrian Barnett argues that humans are "unique" because "we are the only living member of our genus" (3 February, p 47). It was, of

course, a human, Carolus Linnaeus, who invented the system of classification. As well as making sure that he himself was not in the same genus as his closest relatives, the other great apes, he worked out a system of "race" in which Europeans like himself were supposedly members of a superior race as well being a "unique" species.
Prague, Czech Republic

Muscle power

From Patrick Leonard
Stephanie Pain describes the strength and stamina of trireme rowers 2500 years ago (10 February, p 46). Only 150 years ago a trained railway "navvy" in the UK was expected to dig out 1 ton of material a day, as I read in a biography of the Victorian civil engineer Robert Stephenson. The steel plates for the box girder sections of his 1850 Britannia Bridge across the Menai Strait were forged by men wielding 40-pound (18-kilogram) sledgehammers. The standard heavy sledge in use today is 14-pound (6.3 kilograms). I have used a 28-pound (13-kilogram) hammer, but it is not something I would recommend, even if you can still get them.

A 19th-century potter throwing flowerpots would use half a tonne of clay in a day. In 1972 in Uttar Pradesh, India, I witnessed 1.5-metre-tall labourers, who could not have weighed more than about 45 kilograms, lifting bags of rice probably weighing 70 kilograms, by rolling the hessian at the top to



obtain a grip and hoisting them up and onto their backs with ease.

I suspect working toughness is what is missing now – something not possible to acquire in a gym.
Southampton, UK

Teens' substance abuse

From Christopher Anderson
In describing "Robo-tripping" you say the abuse of cough medicines such as DXM is "driven largely by the internet" (3 February, p 48). Many websites offer information, but I cannot believe this has led many more kids to abuse DXM.

Listening to peers and following fads is the number one factor. There are songs and cartoons that glorify tripping on the magic syrup, such as MC Chris's *The Tussin*. If anything, the internet is educating teens how to "safely" trip, by suggesting products with only DXM as an active ingredient.
Auburn, New York, USA

Cool running

From Richard Lehman
Jean-Jacques Juillet, who is helping to build the Planck probe to get better measurements of the cosmic microwave background, claims that parts of the electronics "will be the coldest objects in the universe during their lifetime", at 0.1 kelvin (10 February, p 5).

But then you describe an experiment that will cool several million rubidium atoms to "a few millionths of a degree above absolute zero" (p 26). In which case, won't they be the coldest objects in the universe?
Banbury, Oxfordshire, UK

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Technology

OWL SURVEY IS A REAL HOOT

Ever wanted to chat with a bird of prey? Volunteers taking part in a conservation project will soon exchange "hoots" with owls via mobile phone.

For the last four years biologists at Maine Audubon wildlife centre in Falmouth have been enlisting volunteers to go into local woods at night and play recorded owl hoots. This prompts nearby owls to respond, helping the researchers estimate which owls live where, and monitor how populations vary between areas and over time. However, there is no way to check whether the same owl responses are being counted multiple times, which could skew population estimates.

So from next month, volunteers will instead call the owls using 64 phones connected to loudspeakers and microphones spread throughout the

woods. The set-up, created by Dale Joachim and colleagues at the Massachusetts Institute of Technology, allows volunteers to monitor multiple locations simultaneously, and should help biologists work out when two microphones are detecting the same owl. It will also allow volunteers to gather data from their homes, ensuring the presence of people does not impact the owls' behaviour.

To call the birds, volunteers log into a website, select the appropriate hoot and send it to one or more phones, which then play the sound over a speaker. An array of microphones then picks up the responses and transmits them back to the website, where volunteers note which hoots were detected where. See <http://owlproject.media.mit.edu> for full details.



"I'm all ears"

One-stop shop for disaster advice

FORGET about dialling 999 or 911: when the next earthquake or flu pandemic strikes you might find yourself logging on to the internet instead.

Emergency call centres quickly become overwhelmed during large-scale disasters, so Ben Shneiderman and Jennifer Preece at the University of Maryland, College Park, say a specially designed social-networking site could be a big help. Users could report problems via mobile phone or PCs, find out who needs help, and get information on where and when to evacuate (*Science*, vol 315, p 944).

Shneiderman admits it will be a challenge to shield the site from prank attacks and persuade people to contribute, but he says popular sites like MySpace and Wikipedia show people are willing to contribute to such sites.



SOURCE: WIREID.COM

Memory sticks? Swabs, more like

IMAGINE having a "living" data storage system that constantly renews itself, keeping the data safe for aeons. A team in Japan has raised the possibility by loading live bacteria with artificial DNA sequences that encode data.

Because the data is passed on with the bacteria's own DNA, it will survive indefinitely provided the colony is kept alive.

"Information storage using DNA will probably be robust for more than a million years," says Ohashi Yoshiaki, head of the team at Keio University in Yamagata.

He and his colleagues turned the message " $E = mc^2$ 1905!" into binary code written in DNA base pairs, then inserted it into thousands of *Bacillus subtilis*, a common soil bacterium. For extra security, the team encoded the message in four distinct DNA sequences. (*Biotechnology Progress*, DOI: 10.1021/bp060261y).

DOING IT FOR THE KIDS

The One Laptop per Child project has ordered 1 million devices from manufacturer Quanta

5 to 10 MILLION LAPTOPS could be shipped in 2007

7 countries have committed to buy laptops



SOURCE: MACKNORIO

GIZMO

Batteries could one day assemble themselves inside micromachines. Researchers at the Massachusetts Institute of Technology deposited charged particles of the electrode materials lithium cobalt oxide and graphite on a surface. Like types of particle then electrostatically attracted each other to form electrodes (*Advanced Functional Materials*, DOI: 10.1002/adfm.200790011).

An eye implant that bypasses retinal light receptors wrecked by disease is allowing blind people to see again. A wireless video camera mounted on spectacles feeds data to an image sensor implanted in the retina. Six people fitted with the device can now see well enough to identify objects and detect motion. Developed at the Doheny Eye Institute in Los Angeles, it should be available to the public by 2009 for \$30,000.

"MySpace had no duty to protect Julie Doe from criminal acts"

Texas district judge Sam Sparks, in a ruling on why he was dismissing a lawsuit filed against the social networking website on behalf of a 13-year-old girl who claims to have been sexually assaulted by a man she met on the site. Criminal charges are pending against the man (AFP, 15 February)

Rover and pals help troops tell friend from foe

The US and its allies have been trying hard to improve a dismal record of attacking their own soldiers

PAUL MARKS

THE video clip makes shocking viewing. Two US fighter pilots are told over the radio that there are no friendly forces in their area.

Reassured by this false information, the pilots dismiss the distinctive orange "friendly" markings on the four tanks beneath them, convinced that they are orange Iraqi rocket launchers. One then attacks, killing British soldier Matty Hull and severely injuring four others.

The clip, leaked to British newspaper *The Sun* earlier this month, throws into sharp relief the military's failure to tackle the problem of friendly fire. In both the second world war and the Vietnam war, according to US government figures, 15 to 20 per cent of US casualties in combat were the result of friendly fire. And despite advances in GPS satellite navigation and weapons guidance systems the rate had increased to 24 per cent during the first Gulf war in 1990. As Hull's death starkly illustrates, little had changed by the start of the Iraq war a decade later, where the first few months saw a spate of incidents involving friendly fire (see Table, right).

This may be about to change, however, as a number of technologies are emerging that could help reduce the death toll

due to friendly fire. Pinpointing the cause of such killings is often difficult, as they can involve a mix of navigational error, incorrect target identification, flawed intelligence and a lack of discipline by pilots and troops. The British inquest into Hull's death resumes on 12 March, after it was suspended when the UK Ministry of Defence refused to let the cockpit video be screened in evidence. Last week, the coroner reluctantly agreed not to show the video in open court. What is clear from the leaked clip is that the forward air controllers, who

support ground operations by directing aircraft to their targets and telling pilots where friendly troops are, relied on the pilots' verbal description to work out what they were looking at – and where – and then respond with instructions. This is a time-consuming, error-prone process, as pilots' descriptions of their location or what they are seeing can be vague, says Greg Harbin, a director of operations with the US air force's 609th combat operations squadron in South Carolina.

In 2003, when the incident took place, there was no other option, he says. Now, thanks to a simple question posed by Chris Manuel, a forward air controller in Afghanistan in 2002, Pentagon engineers have developed an anti-friendly-fire system for aircraft that is already showing some signs of success.

Manuel was frustrated because he could not see exactly what the pilot sees from the cockpit. The problem was solved by putting a video transmitter inside each aircraft's camera pod.

As a result of this simple step, the battlefield scene in front of a pilot can now be broadcast to a laptop in the hands of a forward air controller on the ground up to 16 kilometres away. Called Rover –

for Remotely Operated Video Enhanced Receiver – the system is vastly improving mission accuracy, Harbin claims.

Using a touch screen, the controller can circle a target vehicle or building and the pilot will see the same thing on their cockpit screen. In the same way friendly forces, or innocent bystanders, can be highlighted and avoided. "We now have the technology to see on the ground what the pilot sees before, say, a bomb is released," says Harbin.

There are now more than 1500 Rover kits being used by coalition forces in Iraq and Afghanistan. "We are working with the British to put Rover video downlinks on their fighters, and forward air controllers there have already used it to great effect," says Harbin. Had Rover been available in 2003, he believes Hull's death might have been avoided, as the controllers would have correctly identified the friendly vehicles the aircraft were targeting.

What's more, the Rover-equipped laptops also have secure wireless internet connections that allow troops to chat online via instant messenger, or access video from aircraft transmitted to portable devices like iPods and PDAs via radio link. This means that even if a controller is forced to leave their vehicle, they can keep in contact with the pilot to ensure they have the correct information. "We are taking advantage of the internet and iPod generation coming through the military," says Harbin.

Rover was first tried out in Iraq in 2004, and it is now used in 90 per cent of missions that involve close air support, says Harbin. In those missions, there have been no friendly fire deaths, he says. "I think if it is used properly Rover will virtually eliminate fratricide."

However, air support for ground operations is just one area where troops are at risk from friendly fire. Tank to tank, missile to aircraft and maritime attacks can be just as risky. And at a time when most military operations are carried out by coalitions of

UNDER FIRE

Friendly fire incidents since start of Iraq war

Date	Environment	Details
23 March 2003	Ground to air	US Patriot missile shot down RAF Tornado, killing two British airmen
25 March 2003	Ground to ground	British challenger 2 tank engaged second challenger 2 tank. Killing two soldiers and wounding two
28 March 2003	Air to ground	US aircraft attacks British vehicle, killing one soldier (Matty Hull) and wounding three
30 March 2003	Maritime	British marine killed when his landing craft came under fire from British rockets
2 April 2003	Ground to air	US Patriot missile downs F-18 fighter jet, killing one US pilot
6 April 2003	Air to ground	US aircraft bombs a convoy of Kurdish fighters and US special forces, killing 18 Kurds and wounding 45
4 September 2006	Air to ground	Two US A-10 aircraft fired on NATO forces in southern Afghanistan, killing one Canadian soldier and wounding five



Does the pilot know which side they're on?

nations, it is more important than ever that friendly forces develop compatible "combat ID" systems.

NATO is in the vanguard of such efforts. At its Allied Command Transformation headquarters in Norfolk, Virginia, Nick Keen and Joe Chacon are working on a US-led programme which aims to create a ground combat ID system for NATO's member countries. Progress so far has been sluggish. A pan-NATO system was meant to be up and running by 2006 (*New Scientist*, 5 April 2003, p 4), but homing in on the right technologies has taken longer than expected.

NATO has now narrowed the search down to two anti-friendly-fire technologies after testing four in Operation Urgent Quest. These manoeuvres involved NATO and

Australian forces and were organised by the UK Ministry of Defence on Salisbury Plain, Wiltshire, in September 2005. One of the two most promising technologies, the Battlefield Target Identification Device (BTID), is a millimetre-wave radio transceiver for ground vehicles that sends back an ID code, complete with GPS coordinates, when interrogated by another vehicle's device. "We put BTID through a series of battle runs in which a live enemy provoked the sorts of scenarios that can lead to fratricide. To try and confuse BTID, vehicles would appear from all angles with no notice.

However, it behaved itself and looks very promising," says Keen.

Also tested was a system called Radio Based Combat ID. Unlike

BTID, vehicles don't have to be fitted with specialist equipment. Instead, it harnesses the existing GPS-equipped radios in vehicles and aircraft to transmit the ID and position of all friendly vehicles in the area. "Many of the NATO nations have GPS situational awareness built into their radio systems, like the UK's Bowman radio," says Keen. It worked well in tests on ground vehicles and fast jets but the downside is that not every nation has equipped its forces with GPS-based radios. NATO is expected to decide on a system within two years.

In the meantime, NATO vehicles in Afghanistan are already using a non-standard version of the radio ID system. Called the Friendly Force Tracking System (FFTS), it uses on-board GPS receivers to report each friendly vehicle's location by radio. "A central control centre then retransmits all the friendly

vehicle locations to all the units in the network," says Chacon.

No one is pretending friendly fire can ever be completely eliminated – especially in ground combat at close quarters. But technologies that enhance location awareness will help reduce it, says Ivan Oerlich of the Federation of American Scientists, who has investigated friendly fire prevention for the US Congress. Oerlich says that purpose-built anti-friendly-fire technologies like BTID are losing out to communications systems like Bowman that also enhance navigation and, by dint of that, improve combat identification.

"The friendly fire problem will then be taken care of, because these systems help prevent misidentification," Oerlich says. "Putting GPS radios on all vehicles is a huge tool in fratricide prevention – even though it might not look like one." ●

"We have the technology to see on the ground what a pilot sees before a bomb is released"

Satellites vs space junk: evening up the odds

THE threat to spacecraft from fast-moving space junk could be lessened thanks to a new way to measure how much fuel satellites have left in their tanks.

Satellite operators need to know when a craft is running low on fuel so they can use the last of its propellant to thrust it into a high-altitude orbit out of the way of other spacecraft. Accuracy is everything though:

ditch a satellite too soon and a multimillion-dollar resource is wasted early; leave it too late and you create hazardous space junk.

At present, the fuel level is calculated either by estimating how much is used on each thruster burn, or using a sensor to measure gas pressure in the tank. Neither method is accurate, particularly when fuel runs low.

Now aerospace engineers Amit Lal and B. N. Raghunandan of the Indian Institute of Science in Bangalore have solved the problem by designing a fuel tank with a titanium alloy cone inside it (see Diagram).

In microgravity, the greatest forces come from surface tension, and the fuel tends to coalesce into a large mass, says Lal. As the fuel runs low "it eventually migrates towards the converging end of the cone to minimise its surface area",

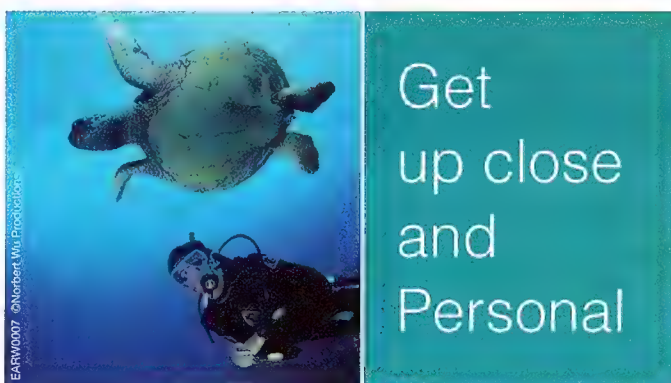
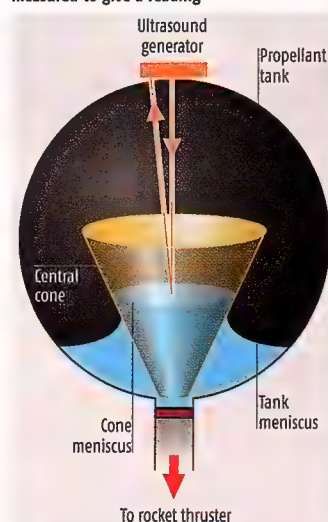
he says. Meanwhile, fuel outside the cone moves towards the base of the tank for the same reason.

The researchers found the fuel inside and outside the cone eventually reached equilibrium, with the meniscus heights of both remaining constant relative to each other. So by bouncing an ultrasound beam off the fuel in the cone and measuring its return time, Lal believes they will be able to accurately calculate the fuel left in the tank (*Journal of Spacecraft and Rockets*, vol 44, p 143).

Todd Barber of NASA's Jet Propulsion Laboratory in Pasadena, California, says the idea could also help planetary probes. "For a planetary mission such as Cassini, measuring the remaining propellant more accurately would enable better decisions to be made about potentially extending the mission." **Paul Marks** ●

MEASURING REMAINING FUEL

As the amount of propellant runs low, the relative height of the menisci in the cone and tank remains constant, so only one – the cone meniscus height – need be measured to give a reading



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Kill a cancer by filling it with holes

THEY dispense a thousandth of the power it takes to illuminate a light bulb, yet electrodes inserted into tumours for just 15 minutes could inflict a decisive blow on cancers and other diseases.

What's more, they could destroy tumours without inflicting collateral damage on surrounding tissue, unlike treatments such as radiation therapy. When prostate cancer patients are treated, for example, the urethra often gets accidentally damaged.

In April at least 10 patients with prostate cancer will become the first to receive the treatment, developed by Boris Rubinsky of the Hebrew University of Jerusalem in Israel and colleagues in the US.

The researchers have shown that mild electric fields can kill diseased

tissue in pigs. The fields cause microscopic surface pores to open up on the cells – a process called irreversible electroporation – gently killing them within hours. Crucially, the process only acts on diseased cells, leaving intact all the other structural components of an organ, such as blood vessels, gut walls, connective tissue and ducts.

In experiments on damaged pig livers, the researchers killed the damaged cells by applying a voltage across them using two 1-millimetre-thick electrodes. All the blood vessels and ducts in the liver remained intact (*Technology in Cancer Research and Treatment*, vol 6, p 37). "In two weeks, healthy tissue had been completely regenerated, something that would take at least six months [after other therapies]," says Rubinsky.

The team's breakthrough was to identify electric fields powerful enough to permanently open pores but weak enough to prevent damage to the rest of the organ by overheating it. They apply a voltage of 1.5 to 2.5 kilovolts in microsecond pulses.

Rubinsky hopes that many solid cancers can be treated with the therapy. **Andy Coghlan** ●

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NS070P03



Green sky thinking

Could maverick technologies
turn aviation into an eco success
story? Yes – but time is running
out, says **Bennett Daviss**

WE LOVE jetting off to faraway beaches, and the occasional business junket or foreign city break is hard to resist. Sure, we fret about the greenhouse gases and other pollutants these flights generate, but we quickly put it to the back of our minds. After all, politicians round the world seem to say that it's OK to fly.

In a television interview in January, for instance, UK prime minister Tony Blair suggested we don't need to give up flying since scientists and engineers are developing new fuels, engines and airframes to mitigate its impact. "What we need to do is look at how you make air travel more energy-efficient," he said. "If you use the science and technology constructively, your economy can grow, people can have a good time but do so more responsibly."

It's a view shared by many politicians in the US, which represents a third of the world's market for commercial flights. But with so much at stake, are such reassurances enough? On the one hand here is an industry enjoying massive growth, with ever more of us zooming off on ever cheaper jaunts. On the other is the undeniable fact that flying produces huge quantities of greenhouse gases and other pollutants. So can technology really turn aviation green? More importantly, can it do so before it's too late?

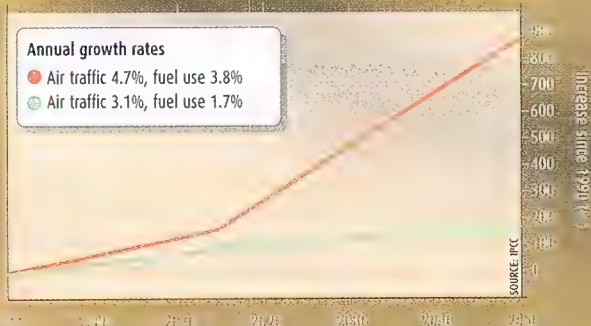
The aviation industry itself seems remarkably sanguine. According to the International Air Transport Association, today's jet engines are around 40 per cent more fuel-efficient than those designed in the 1960s, and engineers have almost eliminated pollutants such as soot and sulphur from jet exhaust. Advances like these, it promises, are set to continue. The Advisory Council for Aeronautics Research in Europe (ACARE), for instance, a body made up of representatives from the aviation industry, government and academia, has launched a strategy that includes halving carbon dioxide emissions and reducing nitrogen oxide (NOx) emissions by 80 per cent.

But before you conclude you can enjoy those complimentary nuts with a clean conscience, take a closer look. Around 85,000 commercial flights take off each day, and this number is predicted to double by 2050. Despite healthy advances in fuel efficiency over the past 30 years, experts agree that further improvements will be far more modest. The problem, according to Dennis Bushnell, chief scientist at NASA's Langley Research Center in Virginia, is that the aviation industry is mature, and conservative to boot. Much of today's aerodynamics research is a "sunset endeavour", he says. "There is not much left to gain except by the glacial accretion of a per cent here and there over long time periods."

The result is a widening disparity between the air industry's

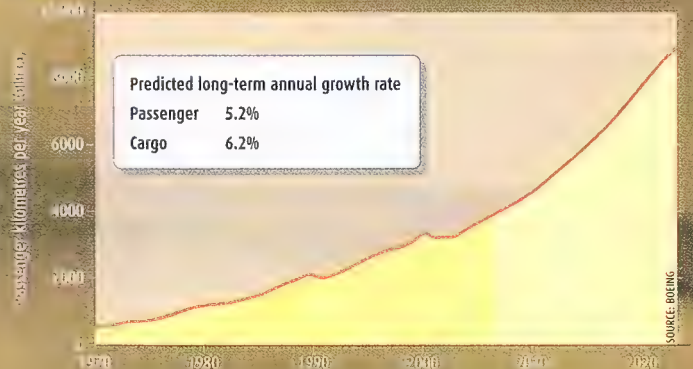
AVIATION'S GROWING IMPACT

How much carbon will the aviation industry release in 2050? No one is sure, but the Intergovernmental Panel on Climate Change has developed a range of scenarios based on different assumptions for the average annual increase in air traffic and more efficient use of jet fuel.



MORE PEOPLE WILL TRAVEL BY AIR

Passenger numbers are expected to use steadily, with freight increasing even faster.



growth – over 5 per cent annually – and the projected improvement in jetliner fuel efficiency, which is nearer 2 per cent each year. Even ACARE sets no firm timetable for its goals, saying only that the cuts in emissions will come sometime beyond 2020. Reaching them will require “substantially more output” from aeronautics researchers and “important breakthroughs” in technology.

So where will these breakthroughs come from? Not from conventional aircraft design, warns Bushnell. If the industry wants to continue to grow but grow green, it will have to make some radical changes – and take some radical risks. What we need is little short of a design revolution.

One thing that will be hard to shake off is our addiction to air travel, which of course is fuelled by kerosene. Jetliners burn about 130 million tonnes of the stuff each year. A single flight across the Atlantic can guzzle about 60,000 litres – more fuel than an average motorist uses in 50 years of driving – generating around 140 tonnes of carbon dioxide, along with 750 kilograms of NO_x. At around 10 kilometres up, where most airliners fly, NO_x is very efficient at creating ozone, which at these heights helps to warm the planet. Additionally, water vapour in the exhaust creates contrails that act as seeds for cirrus clouds, reflecting heat back to Earth.

The net result, according to the Intergovernmental Panel on Climate Change, is that pollution from high-flying jets is up to four times as damaging to the environment as the same amount released by chimneys and exhaust pipes at ground level. Yet while other polluters are busy cleaning up, the aviation industry’s continued expansion is set to transform it into one of the largest single contributors to global warming.

Trees to the rescue

That’s not to say the problem is being ignored. Business is booming in the carbon offsetting trade, for instance. If you plan to fly, you can pay any of a growing number of offsetting companies to plant trees or invest in green-energy projects. The idea is that by storing carbon in forests or by building wind turbines, they can offset your personal share of the flight’s greenhouse emissions. Carbon-neutral fuels are also being explored. Last September, Richard Branson, owner of the Virgin airlines, revealed plans to invest \$3 billion in developing ecologically friendly plant-based jet fuel. Unfortunately, though, both carbon offsetting and biofuels are less than perfect solutions (see “Frugal flying”, opposite).

So what are the aircraft manufacturers doing? Until now, their main motivation for R&D has been to reduce operating costs. They

“Pollution from high-flying jets is up to four times as damaging to the environment as the same amount released by chimneys and exhaust pipes at ground level”



have gradually improved the fuel efficiency of jet engines, while lightweight alloys and composite materials for fuselage and wings have increasingly helped aircraft fly further on a tank of kerosene. Change has been incremental, however, and each small advance has been driven more by short-term profit than the pursuit of more energy-efficient technology. Moreover, mergers between manufacturers have reduced competition between designers.

These days, Bushnell says, manufacturers have little incentive to include cutting-edge ideas in their creations. “It’s terra incognita,” he says. “Dragons be here.” As a result, the latest jetliners from Airbus or Boeing are essentially identical to planes developed in the 1950s.

Yet there is no shortage of innovative ideas out there. In some cases they have even made it to flight tests. Take drag control, for instance – a technique that improves efficiency by reducing friction between a plane and the air. For minimal friction, the thin layer of air closest to the surface of an

aircraft should flow smoothly – something engineers call laminar flow. In practice, however, this boundary layer flowing around a jet’s wings can easily become disturbed and peel away from the surface. This creates turbulence that can account for up to 40 per cent of a plane’s total drag.

To eliminate this, engineers have investigated an idea called laminar flow control. Put tens of thousands of tiny holes along the top of an aircraft’s wings and a fan inside can suck the disturbed boundary layer back towards the wing. This removes the fuel-wasting turbulence, leaving a smooth flow in its place (see Diagram, page 36).

From the late 1970s onwards, the aircraft industry worked hard on laminar flow control, from theory to flight tests, to the point at which the technique could reliably reduce drag by up to 20 per cent on everything from fighter jets to airliners. But work halted in the 1990s when fuel prices dropped. “We stopped doing the research because the cost of installing and maintaining the suction system didn’t pay for itself over the life of the plane,” Bushnell says. Complications such as the need to clear dust, insect remains and ice from the holes increased the cost of the system.

Other forms of drag control might offer even greater benefits, but have received little attention from the aviation industry. One intriguing idea aims to combine laminar flow control with a specially modified fuselage to slash a plane’s drag.

The idea was conceived in the 1960s by Fabio Goldschmied, an engineer working on submarine propulsion for the US navy. He calculated that by sucking water in through a slot towards the stern of a moving submarine and blowing it out the back, the turbulent water flow in this region that causes much of the drag on the hull could be eliminated.

In the 1980s, NASA asked Bushnell to look into the idea, and after talking with Goldschmied he saw intriguing possibilities for applying the idea to aircraft. “I never worked out the numbers or studied it quantitatively,” Bushnell says. “It was just an informal modelling of what Goldschmied appeared to be doing.” At Bushnell’s prompting, though, Goldschmied developed the concept and constructed model fuselages that he tested in a wind tunnel. Using a specially shaped conical rear fuselage and a slot much like the one he suggested for the submarine, he discovered he could almost halve the drag on an aircraft fuselage. In a 1987 conference paper, he suggested this could have a remarkable effect, reducing an aircraft’s power requirement by up to 60 per cent during the important cruise phase of a flight.

Goldschmied died in the early 1990s, but he now has a disciple in David Birkenstock. ►

Frugal flying

Do we have to wait for new types of plane to tackle aircraft emissions?

CONTROL GROWTH OF AIR TRAVEL

Airliners are not covered by the Kyoto protocol, the international agreement to control emissions that contribute to climate change. However, in December European Union environment commissioner Stavros Dimas announced that from 2011 airlines flying in the EU will have to pay for the carbon they emit. The revenue this raises could be used to encourage other industries to cut emissions. Even if that does not happen, the cost could mean higher ticket prices, which might restrain the industry's growth.

This strategy is politically sensitive. Airlines on both sides of the Atlantic have responded angrily, threatening to take the EU to court. On the other side, environmental campaigners complain that the measures don't go far enough.

Part of the problem is one of accounting: should you count emissions in Europe from a plane that took off in the US? Or do you count them at the airport it flew from? Others argue that increasing taxation won't stop us flying. Economist Jan Bruekner at the University of Indiana, Bloomington, studies the influence of the commercial aviation industry on the US economy and calculates that an emissions tax would reduce US air travel by less than 10 per cent.

ELIMINATE OIL-BASED FUEL

Aside from the challenge of creating the expensive infrastructure to produce and distribute alternatives to kerosene such as biofuels or hydrogen, the fuels themselves create problems. Take hydrogen: it doesn't generate carbon dioxide, but it provides only one-quarter as much energy as the same volume of kerosene, so the fuel tanks on a hydrogen-powered jetliner would have to be four times the size to carry the plane over the same distance.

This would create design difficulties, according to a 2006 study by Boeing. A hydrogen-fuelled Boeing 737 would require so much insulation, as well as pressurisation equipment to keep the hydrogen flowing, that the fuel could no longer be stored in the wings. Instead, the tanks would have to sit in the fuselage, necessitating a wider cabin. The extra drag this creates would reduce the aircraft's fuel efficiency.

The other big problem is that hydrogen produces about three times as much water vapour as kerosene when it burns. Above 9000 metres – where airliners spend most time – this water would create larger than normal contrails, which in turn form cirrus clouds that contribute to global warming. Although flying lower could solve that problem, the plane would

then be vulnerable to bad weather as well as use more fuel.

The picture is even worse for plant-based biofuels containing ethanol, even though they might be carbon neutral. They weigh 60 per cent more than kerosene, on top of which you need 64 per cent more volume to get the same energy. An ethanol-fuelled 737, for example, would need a 25 per cent larger wing and engines with 50 per cent more thrust just to get airborne, says Boeing. The stuff also freezes at low temperatures, so fuel tanks would need to be heated. A 2002 report by the UK Royal Commission on Environmental Pollution suggests that because of these problems, planes will continue to rely on kerosene for at least 40 years.

OFFSET OUR EMISSIONS

A growing number of airlines and travel companies have teamed up with businesses that enable air passengers to pay a little extra on top of their tickets to help fund green projects. The idea is that by planting trees or investing in renewable energy, you will cancel out your share of the carbon dioxide released on a flight, eliminating any damage to the environment. Last year an estimated 1.5 million people in the UK paid to offset a flight.

However, environmental

campaigners argue that it is a distraction from the real challenge of reducing emissions. Also, the industry is unregulated, so amongst other problems it's not clear how you quantify the amount of carbon locked in a tree, much less guarantee that it stays there.

CHANGE THE WAY WE FLY

Immense amounts of fuel are wasted as aircraft queue to take off at airports, or in the skies waiting to land. To help reduce this, Virgin is experimenting with electric tractors to tow planes from the terminal gate to the runway before the engines are switched on. The airline estimates it could save up to 2 tonnes of fuel per flight.

Far more could be saved by ending the practice of stacking incoming airliners in holding patterns while air-traffic controllers find a slot for each one to land. Instead software could calculate each plane's most efficient, unbroken descent from cruising altitude to the tarmac, beginning as much as 2 hours away from landing. Program this plan into a plane's flight controls and you can save an estimated 400 litres of fuel per landing. The International Air Transport Association predicts airlines could save 12 per cent of their global CO₂ emissions if air-traffic control systems were more efficient.

Single flight from New York to Stockholm 51.5 tonnes of kerosene burned

100 kilograms of CO₂
high-altitude ozone formation:
greenhouse gas

162 tonnes of CO₂
greenhouse gas

51 kilograms of SO₂
acid rain

900 kilograms of NO_x
high-altitude ozone formation:
greenhouse gas

63.8 tonnes of H₂O
forms cirrus clouds:
more global warming

Total aviation kerosene burned annually 130 million tonnes

A commercial pilot in Virginia, Birkenstock has spent more than a decade investigating the concept.

He envisions a jetliner with a small but key alteration. In a conventional passenger jet, the rear of the fuselage tapers to a point. In Birkenstock's vision, that section becomes a curved-sided cone rather like a lampshade (see Diagram, opposite). Just ahead of the cone, girdling the fuselage, is a slot. Here a fan sucks in air streaming past from the main body and expels it from the end of the cone. This design maintains a smooth airflow across the rear of the fuselage, eliminating turbulence and sudden changes in air speed that create drag. Expelling the air at the rear also adds thrust.

Faster and further

Despite the weight of the fan, Birkenstock suggests that jets fitted with his "aerodynamic engine" could take off from shorter runways, climb higher faster or carry heavier payloads than conventional aircraft, all for the same amount of fuel. "On longer trips, the savings should be significant," he predicts.

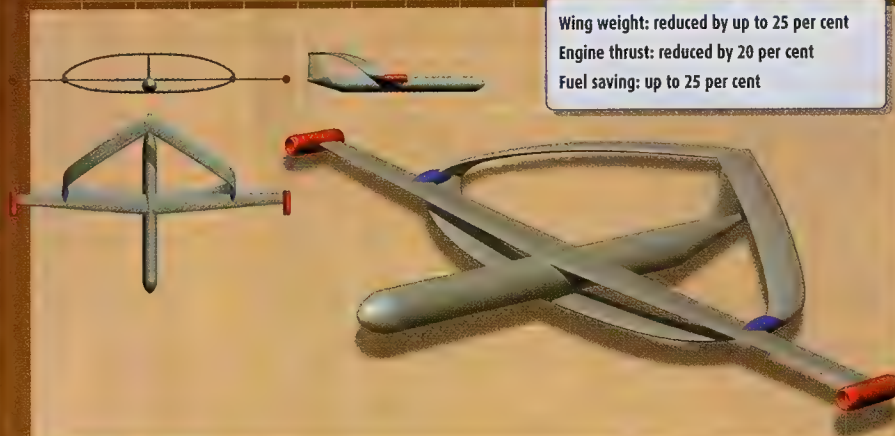
Birkenstock hopes to test this idea on a modified pickup truck, and then on a small aircraft. Unfortunately, Birkenstock's pickup is still parked and it isn't likely to move until he's found out a bit more about the theory. "I've mentioned the concept to a number of engineers, even some who work at Boeing. They tell me to talk to experts on the idea." Trouble is, there aren't any. "It's the position of the profession that aerodynamics has discovered all the important ideas," he says. "That's why Goldschmied's work lies dusty on a shelf in an engineering library."

That also explains why other design ideas are going begging even though they promise to raise fuel efficiency significantly. A three-year study at the Virginia Polytechnic Institute at Blacksburg, for example, has looked at bracing an aircraft's wings using struts – a design that harks back to the 1920s (see Diagram, right). The main aim is to cut the weight of the craft. To withstand the forces of high-speed flight, jetliner wings are built to be strong, and that means heavy, so a plane burns more fuel just to haul itself through the sky. The Virginia Tech researchers calculate that adding a support strut from the belly of the fuselage to the wing means designers can cut the weight of the wing by two-thirds without compromising its strength or the lift it generates. That could improve fuel efficiency by 25 per cent.

Bushnell sees strut-braced wings as a gateway to a host of pollution-cutting benefits. Bracing would allow engineers to lengthen wings without adding appreciable weight and help reduce the impact of

STRUT-BRACED WINGS

Adding support struts to the wings allows them to be lighter and longer. This cuts weight and drag, and if the struts are extended and widened, they also contribute lift. Mounting the engines at the wing tips will cut drag further.



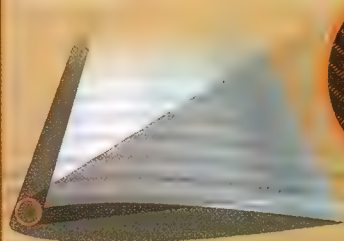
LAMINAR FLOW CONTROL

Turbulent airflow creates drag on wings, fuselage and engines. This can be reduced by sucking air inwards through tiny holes in the airframe, which holds the air close to the surface and retains the smooth "laminar" flow.

Turbulent airflow

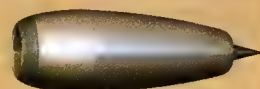


Laminar airflow



Drag reduction: up to 20 per cent on the wings
Fuel saving: up to 10 per cent

Laminar flow control can be used on engines, wings, fuselage and tail



Air sucked in through thousands of tiny holes near the wing's leading edge eliminates turbulent flow and cuts drag

Airflow as it meets the wing

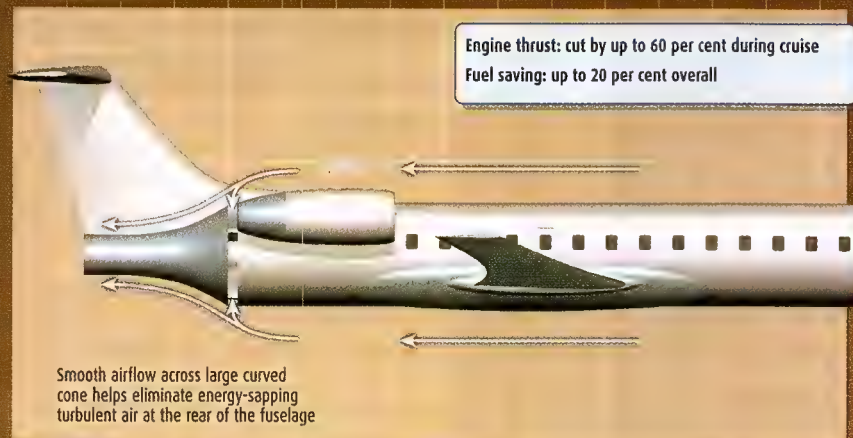


A pump sucks air in



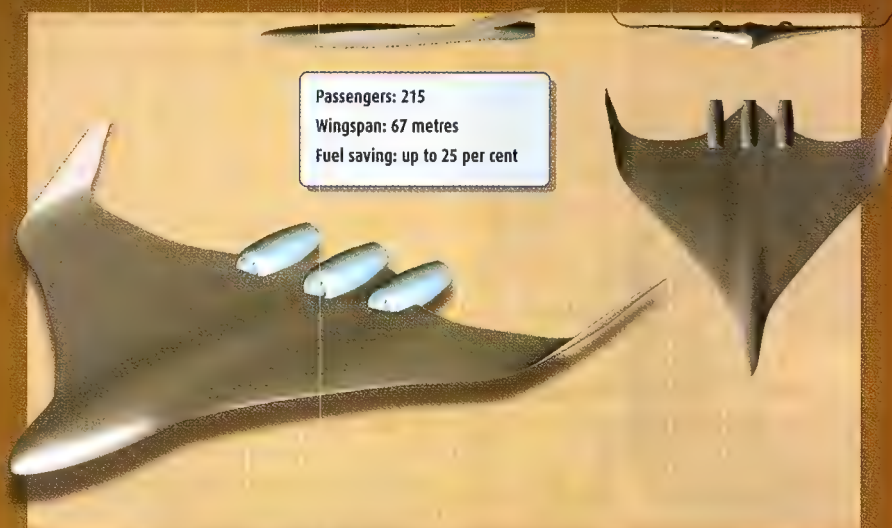
FAST FORWARD

Adding a specially shaped conical extension and a suction slot at the rear of the fuselage can help cut drag. The key is to maintain a smooth airflow across the surface of the cone-shaped extension.



FLYING WING

With its low drag and improved fuel efficiency, the Silent Aircraft Initiative's blended wing body will cut carbon emissions and make far less noise than conventional airliners.



"Though radical ideas like struts are languishing, there are signs that the aviation industry is waking up to the need for change"

"lift-induced drag", which is caused when high-pressure air under the wing meets low-pressure air above, creating a backward-sucking vortex at each wing tip. Placing the engines at the ends of the wings would suck in some of this turbulent air, further reducing drag. You could even widen the struts so they behave like wings, generating extra lift. Biplanes, it seems, might get a second shot at the big time.

Though radical ideas like struts are still languishing, there are signs that the industry is waking up to the need for change. Boeing, for example, has been reviewing a variety of fuel-efficient technologies, including the propfan (see "Take a spin", page 34). Last October nine European aircraft companies announced a €1.7 billion initiative called Clean Sky to develop greener aeronautics systems such as better engines. The following month, a consortium of university engineers and aircraft manufacturers unveiled the results of the Silent Aircraft Initiative, a project to design an airliner that is much quieter at take-off and landing. The result also turns out to be surprisingly fuel-efficient.

Engineers call it a flying wing, or "blended wing body". Gone is the familiar cylindrical fuselage (see Diagram, left). Instead, the craft has a pair of thick, swept-back wings with the engines embedded inside. The tail is also gone, replaced by gyroscopes and raised "winglets" that help keep the plane stable. Rather than flaps, the wings are also equipped with a moveable leading edge that maximises lift. The result is a streamlined plane that is about 25 per cent more fuel-efficient than conventional airliners.

It's not a new concept. US aircraft maker Northrop tried a similar design in the 1940s, but without normal elevators and rudder it proved unstable. Flaps on the wing's trailing edge can help counteract this but are aerodynamically inefficient. A more elegant but complex solution – adopted in the Silent Aircraft design – is to use raised wing tips and tailored wing contours as stabilisers that act in the same way as a conventional tail.

Constructing the cabin space is tricky ▶

Take a spin

Jet engines are not always the best option for short-range flights

Most airliners use jet engines called turbofans instead of piston-driven propeller engines because jets offer more power for their size and weight. Each turbofan contains a turbojet that powers a large fan at the front of the engine. The fan sucks in air, forcing some of it into a compressor to burn kerosene in the turbojet but shooting most of it out behind the engine to push the plane forwards. The hot exhaust gases from the turbojet also help the plane on its way, but most of the thrust comes from the fan, not the jet exhaust.

The problem is that turbofans have almost reached the limits of their efficiency. "We're reaching a point of diminishing returns,"

says Cesare Hall, an aeronautical engineer at the University of Cambridge who worked on the Silent Aircraft Initiative.

One intriguing alternative is the "open-rotor" or propfan engine. This is similar to a turboprop engine, which uses a gas turbine to drive a propeller, except the propfan uses specially shaped high-speed propellers (see Diagram, below).

This has two main advantages. Firstly, a propfan doesn't send large volumes of air through the engine to produce thrust, so it can have small inlets instead of the turbofan's large scoop: without that bulky housing, a major source of drag is gone. Second, by making use of specially shaped counter-rotating propellers, the design

avoids generating "swirl" – the vortex of wasted energy that usually trails in the air behind aircraft propellers.

Over long-haul trips, turbofans will still be more fuel-efficient. However, on trips of less than 3000 kilometres, propfans should provide better efficiency. When US aircraft manufacturer McDonnell Douglas flew a prototype engine in the 1980s, for instance, engineers measured a 30 per cent reduction in fuel burn. Unfortunately fuel prices dropped, and the engine was abandoned. Work on civilian planes since then has been slow, although Ukrainian plane maker Antonov has developed a military transport propfan plane, the AN-70 (see Photo).

too. The interior of a conventional fuselage is cylindrical, a shape that is easily strengthened to withstand pressurisation at high altitudes. The cabin space of a flying wing would be a more complex shape, making it harder to construct from lightweight composite materials. Even the smallest weakness could spell disaster.

Tom Hynes, an aeronautical engineer at the University of Cambridge, foresees other hurdles that might put passengers off. "Will people accept fewer windows?" he asks. Then there's the quality of the ride to worry about. When a conventional airliner rolls from side to side in turbulent air, passengers in the narrow, cylindrical fuselage move relatively little. But with passengers spread out across a cabin up to 20 metres wide, the slightest movements could leave those furthest from the centre feeling like they're riding a roller coaster.

Most importantly, it would take \$10 to \$15 billion and more than a decade of testing to develop such a plane. It's not clear who would be willing to spend this kind of money on a new jetliner, or how quickly it could be developed. "What happens if it doesn't work?" Hynes asks. "And who takes that risk?"

The US air force seems interested – in a military version, at least. It is already working with Boeing to develop a flying wing called the X-48B. The design has passed wind-tunnel tests, and last November a small-scale prototype with a wingspan of 7 metres began flight tests to assess its stability.

Though the X-48B might end up as a bomber rather than an airliner, the flying wing is clearly beginning to look like part of the aviation landscape. Even then, the team behind the Silent Aircraft Initiative is taking no chances: to ensure their design is not too radical for the risk-averse world of commercial aviation, they have drawn up a second, less ambitious version that includes conventional engine pods sitting above the wing rather than inside. Fuel efficiency might not be so good, but it's a compromise that the airline industry might find easier to stomach.

Without tighter emissions controls in force, this kind of compromise could be the only way to get ideas like the flying wing to the departure gate. "These are high-risk technologies," says MIT-based engineer Zoltan Spakovszky, joint leader of the Silent Aircraft design team. "It will take time to evolve them." Sometimes even revolutionaries have to embrace a bit of old-fashioned evolution. ●

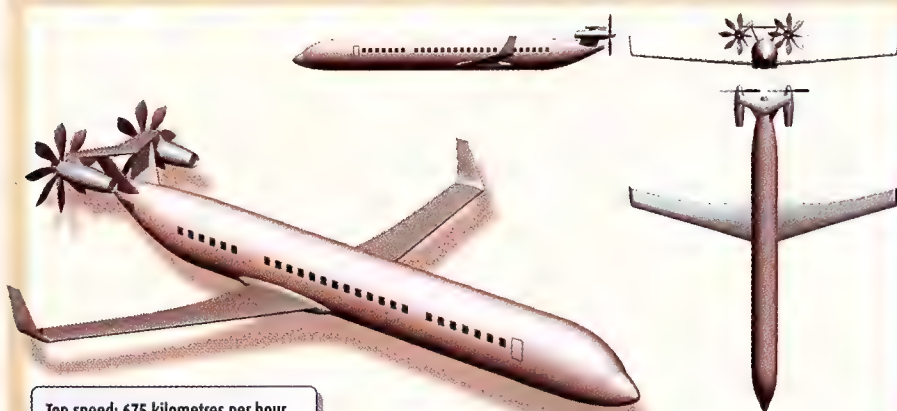
Bennett Daviss is a science writer based in New Hampshire

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OPEN-ROTOR ENGINES

An open-rotor or propfan engine uses a modified jet turbine to drive specially shaped propellers that create less drag. Though slower and noisier than a jet engine, a propfan uses far less fuel. It will perform best on flights of up to 3000 kilometres



Top speed: 675 kilometres per hour
Fuel saving: up to 30 per cent



WORLD OF WARCRAFT/BLIZZARD

Virtual outbreak

Gaming has never been more serious, says Kim Coppola

UNTIL that fateful day, 20 September 2005, the disease was unknown. But once the outbreak began, its effects were devastating. For many, the infection was lethal. Dying victims oozed contaminated blood through their skin and anyone coming into contact with it quickly succumbed.

It all began when a group of adventurers encountered a deadly virus while exploring a labyrinth of caves. When surviving infected explorers made it back to civilisation, they initiated the outbreak. Travellers spread the word, and the disease, only boosting the carnage and the outbreak to epidemic scale. In the busiest towns, bodies piled high.

This is a true story. But there's a good reason you may not have heard about it. The disease took place inside a computer game called World of Warcraft, a virtual world where upwards of 7.5 million people log on to live fantasy lives where they kill monsters and collect treasure.

The disease, christened the "Blood Plague", was made by Blizzard, the game's developers. It was supposed to be just a bit of a fun – and to remain within the caves. When it spread, catching Blizzard programmers by surprise, it inspired scientists to look at virtual worlds as a new place to conduct serious research on people's behaviour. In the future, subjects as diverse as government decisions on how ▶

to contain a disease and theories of social behaviour could be based on knowledge gained through experiments in the virtual world (see "Online obedience", opposite).

Of course, computers have long been used to model the real-world spread of disease. For example, at the Discrete Simulation Sciences office of the Los Alamos National Laboratory in New Mexico, researchers use computer simulations based on statistical models to examine how diseases such as smallpox might spread in the US, and how they might be affected by various vaccination and quarantine strategies. For their Episims project, which is designed to model outbreaks in Portland, Oregon, researchers gathered census and transport records, and used the information to simulate the behaviour of every Portland citizen at 10-minute intervals, including where they travel and who they interact with in a normal day. They were then able to simulate how a disease might spread through this population.

The problem is the model only captures people's routine behaviour. Epidemics can lead to all sorts of out-of-the-ordinary activities, and panic can cause people to behave in completely different ways. The Episims model does not extensively modify behaviour once the disease begins to spread. "The model is very good at examining where

greatly affect the outcome. So if you know 30 per cent of the people are going to run away, and 30 per cent of them are highly susceptible to the disease, it makes a huge difference to the outcome of the disease whether or not that's the same 30 per cent," she says.

Out of control

That's why the World of Warcraft plague got Fefferman so excited. Here was a chance to gather accurate information about how each of thousands of individuals might behave in an outbreak, a study that would be virtually impossible in the real world. As soon as she heard about it she phoned Blizzard. "I wanted to know exactly what happened," she says.

Press reports at the time described how the disease spread out of Blizzard's control. They had intended for the disease to remain within the caves. When the plague spread to the towns, they didn't know how to stop it. Even quarantine didn't work. In the end, to stem the epidemic, Blizzard had to take many areas of the game off-line. Fefferman reasoned that people would have behaved in a similar way to how they would during a real-world outbreak. She wanted to see if the outbreak held lessons for real-world disease control.

Key to Fefferman's idea is that in virtual worlds each character is controlled by a real

willing to modify its game's code so that characters can be infected involuntarily. Fefferman would then seed a disease and wait to see what happened. She has spent 18 months devising a way to use virtual worlds to model the spread of disease. The games company would need to provide her with detailed information on the outbreak, including every character's movements, who they met, when and where they were infected and so on. She would also like to be able to interview players after the fact to establish why they behaved the way they did. Best of all, Fefferman says, would be to be able to secretly introduce diseases and factors affecting its spread that are beyond the control or knowledge of the players. For example, some characters might be silent carriers – infected but symptomless – while others might be immune.

Virtual-world modelling would not spell the end for statistical models, Fefferman says. They would work in tandem, solving different kinds of questions. Behavioural information from virtual-world modelling could be fed into powerful statistical modelling software to refine our assumptions about how diseases really spread.

So far, though, games companies have given Fefferman's plan the cold shoulder. For

"You can't afford to ignore the subtleties of human behaviour when modelling disease outbreaks"

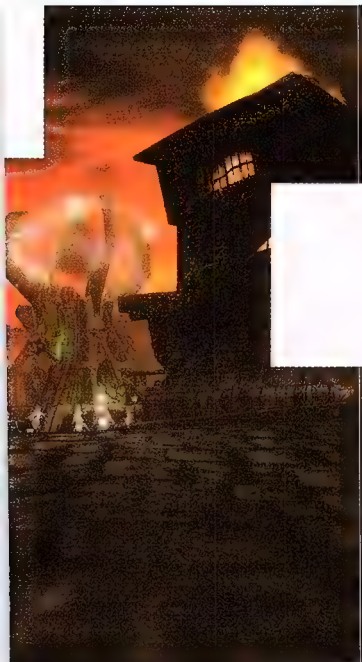
disease will go once we know how people will behave, but if that [behaviour] changes, the model falls down," says Nina Fefferman, who studies disease control at Tufts University School of Medicine in Boston. In the Episims model, if an individual is sick enough, they stay home; if they have a sick child, one parent stays home. Otherwise, business continues as usual. Their model does not take into account the complex and unpredictable human responses to a disease outbreak, such as deliberately avoiding places where there are infected people. This is a crucial drawback, says Fefferman. Human behaviour is a fundamental component of how a disease spreads. Ignore its complexity and the results of your simulation could be wildly out.

"We know from the statistical modelling that having clumps of similar behaviours can

person, rather than being just a statistic in a simulation, which means you don't need to try to predict their behaviour; you can observe it. "The real advantage of virtual-world modelling over statistical modelling is that for statistical modelling to work at all, you need to know how people will behave in advance," Fefferman says. In the virtual world you can look at the behaviour in response to the disease. For example, infected characters might flock to healing areas just as real-world victims would head for hospitals.

Unfortunately, though, Fefferman was not about to get anything useful from the Blood Plague outbreak. Blizzard had been so busy trying to stem the spread of the disease, they hadn't thought to keep track of the statistics. So Fefferman will have to look elsewhere. First she needs to find a cooperative company





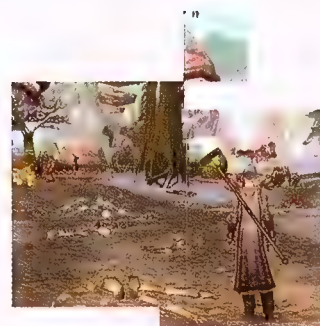
WORLD OF WARCRAFT/BLIZZARD

example, Linden Lab, which created the virtual world Second Life, turned down a recent request from Fefferman to model epidemics in the game. They didn't want to do things to their virtual residents without their consent. "They were very nice in suggesting that I could run a 'voluntary participation experiment' within Second Life, but that would defeat my purpose in the study," says Fefferman. Voluntary participation would create self-selection bias – only those who consented to it could catch the disease.

It's not all bad news. According to numerous blog and forum postings, World of Warcraft players enjoyed the Blood Plague outbreak and considered it part of the spectacle of the game. Blizzard has told Fefferman it may consider a planned outbreak at some point in the

dies, that's it. It costs time, and virtual money, to get it back." Characters buy virtual pets in exchange for treasure they've found or in-game cash they've earned, which both take time to acquire. These pets can't be reincarnated for free, so if a player's pet dies, there's a real loss associated with it. And it's not just about virtual pets. People do invest their time, their reputation, and even real-world money in virtual worlds, so many players do feel they have something to lose. One player so firmly identified with the death of his virtual self that he compared Blizzard's slow response to the US government's mismanagement of the aftermath of hurricane Katrina. This might be at the extreme end of the scale, but Fefferman believes that most players feel there's enough at stake in the virtual world for them to care about not getting infected, so lessons learned there can be extended into the real world.

No one is saying, though, that the situations are exactly comparable. Of course there are differences. For most players, the World of Warcraft plague had little real-world consequence. Most enjoyed the event, which they viewed as a kind of unscripted



virtual theatre. After two days Blizzard was able to contain the outbreak, and they reprogrammed the game so that no player could catch the Blood Plague again.

Nevertheless, virtual-world modelling could give valuable insights into how human behaviour makes a difference to the spread of disease, dramatically improving models and the accuracy of simulations. Virtual worlds might even throw up better strategies for combating disease outbreaks. World of Warcraft's virtual plague has kick-started a whole new approach to disease modelling, and its descendants may yet help save real lives. ●

Kim Coppola is a writer based in London

future. "They have promised that if they do incorporate something major like that in a controlled way, they'll call me," says Fefferman.

So does the virtual world hold the key to the future of epidemiology? Dimitri Williams, who studies the social and economic impacts of virtual worlds at the University of Illinois at Urbana-Champaign, thinks not. "You can't model behaviour based on games where the human behaviours don't map to the real world," he says. In virtual worlds there is nothing at stake – die, and you are reborn at the click of a mouse. There is no life-or-death incentive to avoid disease.

That's certainly true of the World of Warcraft outbreak, in which some players spread the disease on purpose. Blizzard's programmers planned only for those visiting those specific caves to succumb to the bloody death, yet some ingenious players discovered they could form a chain of infection. They used their virtual pets – characters can acquire them in this game – to help carry the disease out of the caves and take it to more populated areas, where the plague then spread out of control. For Williams this highlights the basic flaw in virtual-world disease modelling. "No one in the real world tries to spread diseases for fun, for example, so it just doesn't work."

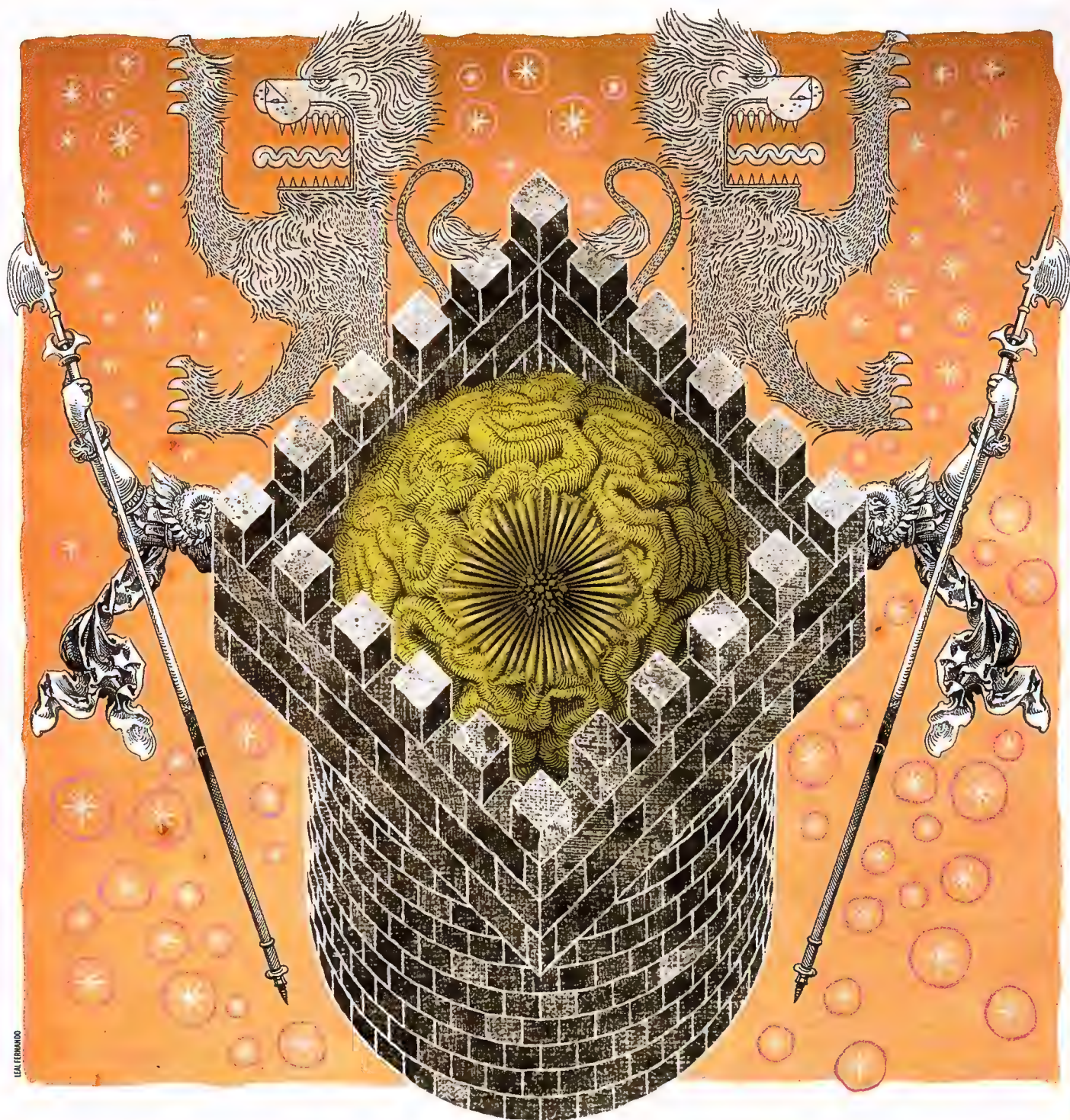
Fefferman disagrees. "There are different risks. World of Warcraft has resurrection, so dying isn't as bad as it seems. But if your pet

Online obedience

Is it possible to draw real-world conclusions from studies of the virtual world? Mel Slater of the Technical University of Catalonia in Barcelona, Spain, wanted to find out.

He decided to re-enact a famous experiment by Harvard psychologist Stanley Milgram, who showed that people would reluctantly obey a figure of authority and administer pain to an innocent subject even as the subject protested in agony. Slater asked volunteers to apply increasing "virtual" electric shocks to a computer-generated character they saw on a screen. They knew the female subject was not real; nonetheless, as she begged for the shocks to stop, and later seemed to fall unconscious, the participants exhibited genuine signs of stress, as if the shocks were being applied to a real person. The implication seems to be that if people identify strongly enough with virtual characters, conclusions from virtual worlds may well extend into the real.

Superimmune



LEA FERNANDO

A little genetic tweaking could give our bodies the power to fight off the most devastating diseases. Dan Jones reports



MARK ORIGER of Watertown, Wisconsin, should be dead. In 2004 it became clear that conventional treatments for his skin cancer had failed. The disease had spread to his liver, and it wasn't clear whether he'd live long enough to make it to his daughter's wedding the following year. Yet he not only made it to the wedding, he is still alive today. His tumours are gone, and he appears to be free of cancer.

What saved Origer was genetic engineering of his immune system. Cells were taken from his body, given a gene that programmed them to attack melanoma cells and then re-implanted. The modified cells survived and thrived, and slowly destroyed his tumours.

Others were not so fortunate. Of the 17 patients in the pilot trial, only Origer and one other man responded to the treatment. But their survival proves the approach can sometimes work wonders – and soon it should help even more people with cancer. “We’ll be able to improve on these results dramatically,” says Steven Rosenberg, chief of surgery at the National Cancer Institute in Bethesda, Maryland, who led the trial.

What's more, this new form of gene therapy isn't limited to treating melanoma or other cancers. Genetic engineering of the immune system could also cure deadly infectious diseases such as HIV, tuberculosis and malaria, and reverse autoimmune disorders such as juvenile diabetes, multiple sclerosis and arthritis.

Our immune systems are incredibly effective, but they are not perfect. Sometimes they fail to recognise enemies such as tumour cells, or mistakenly attack healthy cells, while many pathogens have evolved cunning ways to dodge immune attack or replicate so fast they simply overwhelm unprepared defences.

So ever since Turkish or Arab physicians developed a form of inoculation for smallpox many centuries ago, doctors have been giving the immune system a helping hand. Vaccines have saved hundreds of millions of lives, and the latest generation promises to do everything from preventing cervical cancer to helping treat cocaine addiction. Yet conventional vaccination has its limits, as decades of failed attempts to develop

vaccines against diseases such as malaria and HIV show all too clearly.

Enter the genetic engineers, who are taking the concept of helping the immune system to an entirely new level. This approach can be used to target an immune attack far more precisely than with a normal vaccine, or to tell the immune system when to call off an inappropriate attack. What's more, there is no need to rely on the natural powers of the immune system – cells can be given entirely new abilities and weapons for fighting disease.

Take cancer. As the immune system develops, it learns to ignore the natural components of the body – to distinguish between self and non-self. Because cancer cells derive from our own cells, they can grow and spread underneath the radar of immune surveillance. Our immune systems can mount a response to mutated or aberrantly expressed proteins on tumour cells and probably do kill off many cancers at an early

“What saved Origer was genetic engineering of his immune system”

stage, but all too many slip through the net.

Numerous groups around the world are working on cancer vaccines, but overcoming the body's tolerance of self and persuading the immune system to mount an all-out attack on established tumours is proving far from easy. The results of most trials have been disappointing.

Directly altering immune cells instead could overcome many of the problems. The approach being taken by Rosenberg's group and others, for instance, is to modify cytotoxic T-cells, those that seek out and destroy bacteria or cells infected with viruses. The key to their specificity is a kind of protein called a T-cell receptor that sticks out from their surface. In response to an attack, the immune system generates new sets of T-cells carrying receptors that latch onto the invaders. Add the right T-cell receptor to cytotoxic cells and you can make them target any cell type you want.

In the pilot trial, Rosenberg's team modified patients' cytotoxic T-cells to target MART-1, a protein common on the surface of melanoma cells. First, the researchers took the gene for a T-cell receptor that binds to MART-1 from the cytotoxic T-cells of a melanoma patient whose immune system was targeting the cancer. Next, they extracted cytotoxic T-cells from the blood of the 17 patients and used a retrovirus to add the gene to each patient's cells. Drugs that deplete the immune system were then given to the patients to “make room” for the modified cells before they were injected back into the body – without this step, too few of the cells survive.

In 15 patients the engineered cells were still circulating at high levels two months later, proving that you can remodel the immune system to some extent (*Science*, DOI: 10.1126/science.1129003). While it is disappointing that tumours regressed in only two patients, Rosenberg thinks he knows why: the T-cell receptor used in the study does not bind very strongly to MART-1. “We now have much more potent receptors,” he says.

The results are nevertheless generating great excitement in the field. “This pilot study marks a milestone in tumour immunological research,” says Rienk Offringa of the tumour immunology group at Leiden University in the Netherlands. “The clinical impact might be limited, but modifications to increase efficacy can readily be envisioned.”

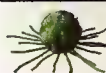
Rosenberg already has his sights set on other cancers. The team is now targeting a protein called p53. This normally protects us against cancer by triggering cell suicide, but mutations can render it ineffective. Around half of all tumours produce high levels of mutant p53, so in theory getting T-cells to target p53 should work against a wide range of cancers. “We've already treated our first patients, and we expect to get results within a year,” says Rosenberg. Other groups are tackling cancers such as leukaemia, and T-cell receptor gene therapy could also be used to target infectious agents, such as the Epstein-Barr virus.

Besides cytotoxic T-cells, antibodies are the other main weapons of the immune system. These free-floating proteins bind to specific viral or bacterial proteins, disabling the invaders or labelling them for destruction. David Baltimore's team at the California Institute of Technology, Pasadena, is planning to take antibody-producing B-cells from ►

THE POWER OF IMMUNOTHERAPY

Taking control of our immune systems could make it possible to prevent or cure many hard-to-treat diseases

THE POSSIBILITIES INCLUDE:



Targeting all-out attacks on cancer cells or pathogens that usually manage to slip under the immune system's radar



Blocking immune attacks on specific proteins to prevent autoimmune diseases such as multiple sclerosis or induce tolerance to transplanted organs



Giving our bodies new weapons such as antibodies that are more potent than any the immune system can generate naturally



Enhancing the immune system so it can outsmart our enemies, such as making immune cells resistant to HIV

people with HIV, genetically engineer them to produce potent anti-HIV antibodies and return the modified cells to the body. "With conventional vaccines, you're limited to what the immune system naturally produces," says Pamela Bjorkman, a protein expert at Caltech who is working with Baltimore, "but we can redesign antibodies so that they work more effectively."

With the help of a \$14 million grant from the Bill & Melinda Gates Foundation, Baltimore's lab is now refining the methods for adding antibody genes to B-cells.

Meanwhile, Bjorkman's lab is grappling with the formidable problem of designing new anti-HIV antibodies, as well as antibody-like proteins that are smaller and better able to access the binding sites on HIV. "Right now we're running tests to see which work best against different HIV strains," says Bjorkman.

She is confident she can create proteins that will remain effective against HIV, despite its high mutation rate. "The virus has evolved to thwart an immune system it knows, but it doesn't know about the protein design tricks that we have up our sleeve to tackle it." Whereas natural antibodies have two identical binding sites for latching onto their target, artificial antibodies can have four different binding sites, minimising the likelihood that HIV will be able to outwit them. Antibodies also interact with other parts of the immune system and can be modified to send out a stronger "alarm call".

Although the technology is some way short of being applied to humans, animal studies have been promising. And the same approach could help to tackle other hard-to-treat infections. "It could be applied to other diseases where there is enough time to intervene this way and there is a need for a new style of therapeutic. Malaria and tuberculosis come to mind, as does hepatitis. There may even be opportunities for treating animal diseases," says Baltimore.

Tackling cancer and infectious diseases involves boosting the firepower of the immune system. Other groups are instead working on ways to prevent friendly fire – the autoimmune diseases caused when the immune system attacks our own tissues. One of the diseases researchers are focusing on is juvenile (type 1) diabetes, caused by the immune system destroying

insulin-producing beta cells in the pancreas.

Potential treatments for diabetes often hit the headlines, but almost all involve ways of replacing the insulin-producing cells – which is treating the symptom rather than the cause. Halting the immune attack would ensure the replacement cells survive and might even allow the beta cells to regenerate naturally if people are treated early enough.

Stopping friendly fire

One strategy is to modify cells to produce immune signalling molecules that damp down autoimmune reactions. Studies of twins suggest that the lack of a signalling molecule called interleukin-4 contributes to diabetes, and mice with no IL-4 get diabetes. So C. Garrison Fathman, an immunologist at Stanford School of Medicine, California, took immune-regulating cells called dendritic cells from these mice and engineered them to express IL-4 before injecting them back into mice. The hope was that the engineered cells would deliver IL-4 to the pancreatic lymph node, the site from which most attacks on beta cells originate. It worked: for reasons no one understands, the modified cells actually homed in on the pancreatic lymph nodes, preventing diabetes in most of the mice. Now Fathman's team plans to find out if the approach will work for people too.

Other groups are working on more specific ways of producing immunosuppressing molecules where they are needed. One technique is to exploit T-cell receptors: add a gene for an appropriate T-cell receptor along with the gene for the necessary signalling molecule, and the modified cell will home in on a specific tissue, such as cartilage. Animal studies at the University of Tokyo show this approach could be used to treat arthritis.

Perhaps the most promising strategy for tackling autoimmune diseases, though, is to intervene higher up the chain, to get the generals to call off the attack rather than disarming the foot soldiers. Several groups have managed to induce tolerance to a specific protein in animals using a variety of approaches, such as engineering B-cells to produce this protein. Such methods could one day be used to induce tolerance to organ transplants as well as for curing autoimmune diseases.

While most immune gene therapies merely redirect the immune system, a few researchers plan to enhance it. Some of the nastiest bugs around have evolved sophisticated ways of evading immune attack. HIV, for instance, not only changes its coat, it also attacks the immune system itself, slowly destroying the body's ability to defend itself.

John Rossi of the Beckman Research

Send in the nanoparticles

While genetically engineering immune cells has huge promise, it is also risky. Some groups are exploring ways to "talk to" immune cells without necessarily altering their genes.

Darrell Irvine at the Massachusetts Institute of Technology hopes to achieve this with sophisticated nanoparticles that could travel through the body and alter immune responses in a far more sophisticated way than a conventional vaccine. His nanoparticles are tiny synthetic capsules that can carry conventional drugs or more sophisticated molecules that would not survive in the bloodstream.

The key is ensuring that

nanoparticles home in on specific cells. Irvine plans to add antibodies to their surface that bind to the target cell. The nanoparticles will be absorbed into the cell, where they release their payload.

The cargo that the nanoparticles ferry to their destination will differ from one disease to the next. In some cases, it might be a protein that draws in other immune cells to fight a tumour. In others, small interfering RNAs could be used to temporarily block the expression of genes that promote autoimmunity. By combining different payloads it could be possible to give cells complex instructions such as "go here and attack this".

"We can redesign antibodies so they work more effectively"



Institute of the City of Hope in Duarte, California, is planning to make the immune system immune to HIV. He wants to take the blood stem cells that give rise to the cells of the immune system from patients, add three genes to them to protect them from HIV and then replace the cells.

The first gene codes for an RNA molecule known as a ribozyme that blocks the expression of the human gene for a cell surface receptor called CCR5, which HIV uses to invade cells. The second produces a short interfering RNA molecule that should trigger the destruction of any viral RNA that still manages to enter the cell. The final gene expresses a "decoy" RNA molecule that should prevent HIV replicating and infecting other cells if it manages to outflank the first two

defences. "We're at the point of filing an Investigational New Drug Application with the FDA, which will allow us start clinical trials," says Rossi.

It's not just bacteria and viruses that evolve ways to outsmart the immune system. Some cancers do too. Certain tumours survive by pumping out an immunosuppressant called TGF-beta, for instance, blocking any attack by immune cells. So Chung Lee's team at Northwestern University in Chicago has developed a way to modify immune cells to ignore TGF-beta. The idea is to isolate cytotoxic T-cells, persuade them to target tumour cells and also to modify them so they are insensitive to TGF-beta. Mouse studies show that these modified cells launch a far more effective attack on prostate tumours

than those that respond to TGF-beta.

While the potential benefits of this new kind of immunotherapy are huge, there are of course some big stumbling blocks. "Safety will be a challenge because there have been issues with gene therapy," says Baltimore. In a French trial, gene therapy triggered cancer in three children (*New Scientist*, 15 March 2003, p 6). This risk might be acceptable to those with a life-threatening illness such as melanoma, but could slow the development of treatments for less serious conditions.

Mucking around with the immune system is also inherently risky. Cancer immunotherapy in particular can trigger a dangerous autoimmunity. "You want a vigorous immune response and maximal efficacy, but you want it to be safe – that is the big challenge," says Offringa.

And while genetic engineering of the immune system could potentially cure diseases that plague poor countries, such as HIV and malaria, gene therapy-based treatments will not come cheap. Baltimore is keenly aware of this problem. "We're trying to design [gene-delivery systems] that will be cheap to make, and we're designing methodologies that will be cheap," he says. "We want to develop these therapies for countries that can't afford expensive drugs, a point the Gates Foundation insists on, and one which I wholeheartedly support."

Rossi points out that conventional HIV therapies cost around \$25,000 a year in the US, or \$250,000 a decade. "The costs of our therapy for HIV are likely to be lower than current drug regimes because this will be a one-shot deal," he says. "Our approach could cost under \$50,000."

The same logic applies to cancer. For instance, treatments for colorectal cancer – which only extend life by up to 12 months – cost \$180,000 annually. Rosenberg predicts that cell-based immunotherapy will cost much less.


There is little point in worrying about the price at this stage, he says. "Right now we need to find things that work, and then we'll work out how to make it economically feasible." ●

Dan Jones is a freelance science writer based in Brighton, UK. See <http://psom.blogspot.com>

www.newscientist.com/channel/health/cancer

Do soap suds have a cosmic secret, asks Jennifer Ouellette

Forever growing

 THE fate of the cosmos could lie in your bathtub. Or perhaps in your kitchen sink. At least that's the view of Joseph Samuel and Supurna Sinha, physicists at the Raman Research Institute in Bangalore, India. They believe one of the most puzzling aspects of the universe could be explained by something as down-to-earth as soap bubbles.

It's all to do with the cosmological constant, a measure of the energy inherent in empty space. This "vacuum energy" causes space-time to push outwards on itself, a phenomenon that astronomers believe explains why the universe is expanding at ever faster rates. Its value determines whether the universe will accelerate gently forever or eventually rip itself to pieces.

The trouble is, none of our best theories can explain the value of the cosmological constant: it is small, ridiculously small, but not zero. This has led Samuel and Sinha to draw an analogy between space-time and the surface tension of bubbles. It's not as strange as it might seem. After all, "the cosmological constant is a kind of tension pervading space-time", says Rafael Sorkin, a physicist at Syracuse University in New York state.

Soap suds have been used to visualise the universe before. In 1986 astronomers Margaret Geller and John Huchra at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, analysed thousands of images of distant galaxies, revealing a structure that resembled a kind of cosmic foam. Geller compared it to a collection of soapy bubbles in a kitchen sink. The "bubbles" that make up this celestial foamy filament are hundreds of millions of light years across. Their "skins" – or surface membranes – are made of galaxies that enclose a volume of space, linked together into gigantic clusters by their mutual gravitational attraction.

It might be bubbles all the way down. Physicists from John Wheeler to Stephen Hawking have famously likened space-time at the smallest scales to a kind of quantum foam, in which tiny bubbles of virtual particles continually pop in and out of existence.

Now Samuel, a gravitational physicist, and Sinha, who specialises in "soft" condensed



Soap bubbles – a useful way to visualise the universe, or just an analogy too far?

bubbles

matter, are adopting a more literal take on this frothy concept. The inspiration for their analogy arose, in part, from an invitation to submit scientific contributions in honour of Sorkin's 60th birthday two years ago.

Back in 1987, Sorkin tackled the problem of how to unite general relativity with quantum mechanics in order to explain gravity at the smallest possible scales. This led him to develop an approach called causal set theory. Samuel and Sinha noticed striking parallels between certain aspects of Sorkin's theory and the bubbles in foam. "In putting our discussion in print, we realised how good the analogy was," says Samuel. "We thought we could exploit it to gain insight into both fields."

Causal set theory and general relativity differ in their basic descriptions of space-time. General relativity treats it as a smooth four-dimensional fabric, with gravity being a result of its geometry or curved shape. The fabric is frozen in the sense that it does not evolve: the past, present and future are all laid out in space-time. Causal set theory argues that space-time can be dynamic and evolves according to the order in which things happen in time. This is called the causal order of space-time. Sorkin's theory says we don't need to know the geometry of space-time. Simply by knowing the causal order of all points within it, we can almost reconstruct it from scratch.

from more popular attempts to unite gravity and quantum mechanics, namely string theory and loop quantum gravity. Other theories predict values for the cosmological constant that are either so high the universe would long have torn itself apart or zero. Sorkin's theory happens to give a value that ties in well with observations made in 1998 of the expansion rate of the universe and its acceleration. This is due to the quantum nature of the causets, which allows the vacuum energy to fluctuate by tiny amounts.

More than froth

Despite this success, causal set theory attracts the same criticism frequently lobbed at string theory. "It is beautiful mathematics without a shred of experimental evidence," says Sidney Perkowitz of Emory University in Atlanta, Georgia, an expert on the physics of foam.

Samuel and Sinha are hoping to change all that. To start, they have proposed a theoretical model of soap suds that could yield useful insights into causal set theory. Every bubble in a foam is made of a thin membrane enclosing a volume of gas. Surface tension along the membrane makes the bubbles clump together, forcing them to adopt a shape with the smallest surface area possible in such a clump, somewhere between a sphere and a cube.

convinced. Cosmologist Joe Polchinski of the Kavli Institute for Theoretical Physics in Santa Barbara, California, is sceptical about the usefulness of soap bubbles. "I am leery of analogies because they often miss key aspects of a problem," he says. For instance, while some researchers have compared the cosmos to an expanding bubble of space-time – or to a balloon filling with air – this can be a bit misleading. Unlike real bubbles or balloons that expand or pull in particular directions, the universe doesn't expand "into" anything, and the push or pull is uniform in every direction. Also, bubbles and balloons eventually pop – a fate no one wants for our universe.

Perkowitz is intrigued by the fact that random bubbles of space-time could lead to accelerated expansion in the cosmos. But he points out that no known physical mechanism for the interaction of such space-time elements could produce a cosmological constant that is on the point of vanishing.

To address this, Samuel and Sinha have designed experiments they believe could be used to test Sorkin's predictions in the laboratory. These would use lipid membranes of the sort found in ordinary shaving foam or beaten eggs because they have a nearly vanishing surface tension, just like Sorkin's predicted value for the cosmological constant. They believe that isolating the mechanism behind the membrane's vanishing surface tension could yield insights into the mysterious mechanism propelling cosmic expansion.

As for Sorkin himself, he considers the analogy "a beautiful idea that opens up the possibility to test the causet explanation of acceleration". In fact, Samuel and Sinha suspect that their concept might not be unique to causets and that other approaches to quantum gravity could also predict a tiny cosmological constant.

If they're right, shampooing your hair could take on a whole new meaning. The key to the nature of ever-expanding universe could be at your fingertips. ●

Jennifer Ouellette is a science writer based in Washington DC. Her latest book is *The Physics of the Buffyverse* (Penguin)

Further reading: "Surface tension and the cosmological constant" by Joseph Samuel and Supurna Sinha, *Physical Review Letters*, vol 97, p 161302

"Shampooing your hair could take on a whole new meaning"

Because causal set theory is a quantum approach to gravity, it assumes that space-time will come in discrete chunks or quanta and orders these elements into sets called causets. They are similar to the branching networks of a family tree, except instead of being related by blood, the elements in the causet tree are related by causation. So as space-time grows, element by element, the quanta link together like bubbles in an ever-evolving and expanding foam.

Although causal set theory is not yet a full quantum gravity theory, it is its predictions for the cosmological constant that set it apart

In this model, the causet elements are like the molecules in the surface membrane of a soap bubble. As well as drawing parallels between surface tension and the cosmological constant, this likens the length of soap molecules to the smallest possible subdivision of space-time allowed by quantum mechanics, the Planck length (10^{-35} metres).

Samuel and Sinha's calculations reveal a critical insight: the surface tension in foam fluctuates before stabilising to zero, just as causal set theory predicts will happen billions of years ahead for the cosmological constant.

It's a promising start, but not everyone is

Once more with feelings

Even after decades of research into artificial intelligence, machines still don't think like human beings. **Marvin Minsky**, the discipline's founding father, refuses to give up hope. His solution is to make machines more emotional – and feelings, he says, are simpler to model than rational thought. He talks to **Amanda Gelter** about the need for emotional machines, the inner workings of the human brain, and the future of AI

Many people are disappointed at the lack of progress in AI since the 1980s. Why so little headway?

In the early years of computing, we found it easy to program machines to solve problems that people regarded as difficult, such as designing efficient aeroplane wings, playing chess, or diagnosing heart attacks. But none of those programs could do the things that people regard as relatively easy – such as making a bed, babysitting or understanding a story from a children's book.

It is much the same today. Each program has only one specialised skill, and when anything happens that isn't expected the computer produces absurd results or gets stuck in an endless loop.

In contrast, humans rarely get totally stuck because we have many different ways to deal with each situation or job. So whenever your favourite method fails, you can usually find a different approach. For example, if you get bored with one particular job, you can try to persuade someone else to do it or get angry with those who assigned it to you. We might call such reactions emotional, but they can help us deal with the problems we face.

You call your new book *The Emotion Machine*. Is that because you're convinced that computers need emotions to help them think in the same way as people?

Yes and no. The goal of the book is to try to explain what gives people their unique resourcefulness so that we can make our machines more versatile. We all grow up with the idea that emotions and thinking are quite different things, that thinking is basically simple because it is mainly a matter of rational logic, whereas emotions are far more complex and mysterious. I take the

opposite view: that emotional states are usually simpler than most of our other ways to think.

Do you have an example?

When someone gets angry, we can see that some of their mental resources switch off. They abandon some long-range plans and goals, and become less cautious and thoughtful. This frees them to be stronger and to think on their feet, making it easier for them to intimidate others. Similarly, a person who has fallen in love might describe a sweetheart as "unbelievably beautiful" or "incredibly intelligent", which suggests the speaker has turned off the critical abilities that are normally used to recognise someone's deficiencies.

Is there such a thing as pure rational thought devoid of emotion?

The traditional view of emotions is that they add extra features to thoughts, just like adding colour to a black-and-white drawing. This makes emotions seem very mysterious because we can't imagine what those extra features are. However, if we regard each emotional state as suppressing some of our usual mental activities, much of the mystery

disappears. Perhaps this is why we have hundreds of different words for emotional states, but we have very few terms for describing our everyday ways to reason and think.

The trouble comes from our failure to recognise that there's no such thing as pure rational thought, because our thinking is always influenced by our current ambitions and biases. Besides, we take common-sense thinking for granted. It works so well that we feel no need to ask how we represent and retrieve the knowledge required for such thinking.

Why is it so difficult to give computers common sense?

Every normal person learns millions of fragments of information. Also, each person accumulates many thousands of useful processes during their life. In contrast, most computer programs have access only to some specialised knowledge about one particular subject. However, this is changing. There are now several ambitious projects that are collecting large amounts of everyday knowledge and trying to find effective ways to organise and apply it.

How could such knowledge be applied to help us make machines more like people?

The Emotion Machine suggests an overall scheme that I call the "Critic-Selector model of mind". The idea is to think of a brain or machine as a system that contains many different kinds of structures and processes: let's call these "resources". Then each of our different "ways to think" – whether emotional or intellectual – is simply what happens in that brain or machine when a certain set of resources is active.

Now let's also add some other resources:

Profile

Marvin Minsky is the Toshiba Professor of Media Arts and professor of electrical engineering and computer science at the Massachusetts Institute of Technology. In 1959 he co-founded MIT's Artificial Intelligence Laboratory, and his many inventions and theories of mind have earned him a reputation as "the father of AI". He is the author of eight books, the latest of which is *The Emotion Machine* (Simon & Schuster, \$26, ISBN 9780743276634). His homepage is at web.media.mit.edu/~minsky/.



“There’s no such thing as pure rational thought”

Does falling in love simply mean our critical abilities are switched off? Marvin Minsky thinks so

Critics, which can recognise some types of problems we face, and Selectors, which can switch different sets of resources on and off. Each set of resources can make us think about things in a different way. We call some of these different ways of thinking “emotional” and others “intellectual”.

For example, if a problem seems too difficult, a Critic can turn on a way of thinking that can try to split the problem into parts, change the way you describe it, solve a simpler version first, find an analogy for the problem or even ask someone else for help.

How much of our lack of knowledge about the way our minds work results from our use of ambiguous language?

Most of our popular words for psychology date from before we developed our ideas about how machines could use diverse kinds of information. Today’s computers use many different ways of representing and storing a huge variety of types of knowledge and processes. Accordingly, my book suggests that each of our traditional words used in psychology refers to perhaps a dozen kinds of machinery.

Is “consciousness” one of these words?

I agree with writers such as Daniel Dennett that there is no single meaning for “consciousness”. In fact, one chapter of *The Emotion Machine* suggests more than a dozen ways in which a particular thought process can know about what other processes are doing. Furthermore, if those processes have different goals, then that person won’t have a single, unified self, but will have multiple “sub-personalities” that may need to compete for the resources they need.

When do you foresee us having sophisticated AI? What will be the major forces driving the development of AI in years to come?

AI researchers have developed many techniques for solving various types of problems, but few of them have tried to come up with schemes that combine multiple ways of thinking. I hope that these new ideas about minds will encourage students to further develop them and influence neuroscientists to design new kinds of experiments to test them. Progress is likely to be slow, though, because most students today have to base their careers on developing practical applications. There is not enough support for basic research in this area. ●

DIFFERENT FAITH, SAME STRUGGLE

As modernity increasingly encroaches on Islamic culture, Muslims are forced to accommodate science within their world view. **John Gray** asks, is the conflict between science and religion the same in the Islamic world as it is in the west?

AFTER a century or more of keeping out of one another's hair, science and religion are once again locked in conflict. The claim that science is the only reliable route to understanding the world is as fiercely disputed today as it was in Victorian times, except that today's standard of debate has been notably unimpressive. If advocates of creationism or intelligent design lack intellectual rigour, then the militant Darwinists who attack religion while knowing virtually nothing of the immense varieties of religious belief and experience are no better.

With both sides ignorant of how science and religion are understood in various traditions, public dialogue has been narrow and parochial. Taner Edis – a physicist working in America, who was born and raised in Turkey and whose early views

“Public dialogue has been narrow and parochial”

were shaped by Attaturkist secularism – aims to rescue the debate from insularity by showing how it has developed within Islam. In doing he so has produced one of the few recent books that truly illuminates the troubled relationship between science and religion.

An Illusion of Harmony is a rich mix of intellectual history, philosophical reasoning and personal insight, which takes as its starting point the paucity of scientific discovery in Islamic cultures in recent centuries. Is this a consequence of political repression and economic underdevelopment, or has Islam itself been a factor in holding back scientific progress?

Edis argues plausibly that for Islam accommodating modern science is intrinsically problematic since it is a text-centred creed in which the Quran is the direct and infallible word of God. Islamic thought contains many disparate strands, but all face the fundamental problem of reconciling the modern belief that the world is governed by knowable natural laws with the religious belief that the world is a product of divine omnipotence.

Of course this difficulty is not confined to Islam, but plagues monotheism in all its forms. Looking back as heirs of the European Enlightenment, many people see western Christianity as hospitable to science by virtue of having absorbed Greek traditions of rationalism. But as Edis shrewdly observes, “Greek rationalism very often conceived of reason as a kind of supernatural illumination providing knowledge of higher realms of truth” – a mystical view



The Islamic tradition is no more hostile to science than the Christian one

that was shared as much by Muslim thinkers as it was by Christians. It is not an absence of rationalism that has stood in the way of Islamic science, but rather the strength of the belief that nature is divinely created.

Just as it has in the US, fundamentalist resistance to Darwinism has produced an efflorescence of pseudoscience in Islamic culture. Edis provides fascinating examples of recent Islamic theories of “guided evolution”, born of the pressures of modernisation. Science has become the key to prosperity and success in war, earning it too much cultural prestige to be attacked outright, so instead religious thinkers try to ape it by developing ersatz sciences that pose no threat to faith.

The conflict between science and religion is not resolved by pseudoscience, but merely evaded.

Any belief system in which human agency is central is bound to be at odds with what Edis describes as the “radically unanthropomorphic” world view suggested by contemporary science. Islamic cultures are no different from the Christian cultures in their struggle to cope with the challenge of science. The true conflict may not be between science and religion, but between science and monotheist faiths in which humans have a privileged place in the world. ●

John Gray is Professor of European Thought at the London School of Economics. His book *Black Mass: Apocalyptic religion and the death of Utopia* will be published in July by Penguin

Turning point

THE ANGEL THAT FLEW TO THE MOON

When a Japanese spacecraft became stranded, Ed Belbruno got the chance to redeem a career that seemed to have hit the rocks

WHEN I was about 5 years old I asked my mother "What's an astronaut?" "Don't worry," she told me, "you're not going to be one." This convinced me I was inadequate in some way – probably not smart enough.

I felt stupid and to make matters worse a favourite expression in my family was "Behind every cloud is a black lining." Hardly a boost to self-esteem. The world was portrayed as a dangerous, untrustworthy place. I worked hard, nevertheless, and in 1981 received a PhD in mathematics from New York University's Courant Institute. Yet the feelings of inadequacy were still there.

My field is celestial mechanics, the way things move in space, and I specialised in studying unstable, chaotic kinds of motion. I had always been drawn to outer space, and this was a way to study it. Another interest



of mine is oil painting, and since I was 7 years old I have painted scenes of distant alien worlds – landscapes of serene majesty and beauty. In some sense, I felt I never really belonged here.

After a spell as a mathematician at Boston University I went to work at NASA's Jet Propulsion Laboratory in Pasadena, California, designing trajectories from Earth to Jupiter for the Galileo spacecraft. How cool!

Working at JPL was exciting and I

If brute force won't get you there, try something more subtle

became interested in applying chaos theory to the design of spacecraft trajectories. I wanted to find a way for vehicles to go from Earth to the moon without using rocket engines to achieve lunar orbit. This would save lots of fuel – and money – and had never been shown to be possible.

In early 1986 I found such a route, which I called "lunar get away

special". The journey would take two years, however, and my colleagues thought it was all a waste of time. My breakthrough was ignored.

Then in January 1990 I got fired. The feeling, said my boss, when he called me into his office, was that my ideas would never be useful. Without a job I thought my world would come to an end. The clouds really did seem to have a black lining.

The turnaround came when I was clearing out my office. I realised that to get my life back on track I needed to let go of the notion that I was stupid. I had nothing to prove to anyone. To my amazement it worked. The stress just suddenly went away.

Then a miracle happened. There was a knock on the door. It was an engineer telling me about a Japanese lunar spacecraft that was stuck in Earth orbit with little fuel, and he asked if I could save it.

By next day we had devised a new route to the moon based on my ideas. The craft was called Hiten, after a Buddhist angel who plays music in heaven. A year later it started out on our plotted path, and in October 1991 it arrived at the moon, a mission that had been considered impossible a few months earlier.

I never got my job back at JPL, but some years later the importance of my work was formally acknowledged by NASA. Thanks to the Buddhist angel, my career has flourished in spite of all I have been through. ●

Ed Belbruno is a mathematician at Princeton University. His book *Fly Me to the Moon* (Princeton University Press, ISBN 9780691128221) is published in March

Enigma

G	I	E	A	N	M
A	M	G	E	I	N
E	N	I	G	M	A
M	G	A	N	E	I
I	E	N	M	A	G
N	A	M	I	G	E

Patience

No. 1431 Bob Walker

PENNY easily solved this puzzle of Joe's. It consists of 36 cards lettered on the back and laid out as shown. On the faces of the cards is one of the letters U for up, D for down, L for left and R for right.

Start with any card, turn it over and

move in the direction shown to an immediately adjacent card and turn it over. Continuing in this way, it is possible to turn over all the cards.

On the Gs are the directions D D D L R & R, on the Es are D D L L R & R, on the Ms are U U U D & L and on the Is there are no Ds. What directions appear on E N I G M A?

£15 will be awarded to the sender of the first

correct answer opened on Tuesday 27 March. The Editor's decision is final. Send entries to Enigma 1431, New Scientist, Lacon House, 84 Theobald's Road, London WC1X 8NS, or to enigma@newscientist.com (please include your postal address). The winner of Enigma 1425 is Ken Guiseley of Hope, Maine, US.

Answer to 1425 Spell check
The RIGHT number is 45798

The wave from nowhere

Shortly after 5 pm on 18 November 1929, an earthquake shook Canada's eastern provinces. In Halifax, Nova Scotia, a seismometer needle jumped right off track. Across the Gulf of St Lawrence, on Newfoundland's Burin peninsula, the tremors sent people running into the streets. But for them, worse was to come. Two hours later, 7-metre waves hit the shore, their momentum carrying them as far as 27 metres above the high-tide level. Boats were smashed and quaysides stripped bare. When the waves retreated, 28 were dead or dying and 10,000 were homeless. Then, to add to Burin's woes, a blizzard hit. It would be three days before news of the disaster reached the outside world. Only now do scientists finally understand the cause of the tsunami: a giant landslide, deep beneath the waters of the Grand Banks.

FIVE-YEAR-OLD Pearl Brushett was snug in bed when the first wave struck the Burin peninsula, lifted her home off its foundations and carried it out to sea. She must have been a sound sleeper because the first thing she remembered was being woken by her mother and peering outside with her four sisters. By then, the house had grounded in shallow water next to an island.

Then the second wave struck, refloating the house. This time it wound up back on the beach not far from where it started. The family didn't wait for the third wave. Unable to use the door, Pearl's mother smashed a pane in the parlour window and with the help of a neighbour they all escaped.

None of the family was seriously hurt, although Pearl's mother gashed her arm when she smashed the window. "Years later Mom still had pieces of glass coming out of her wrist," an ageing Pearl later recalled for a book of reminiscences.

The house also survived. Solidly built, it was washed back to sea yet again by the third and final wave, but was later recovered by a schooner and towed back to town, where it was converted to a storage shed for fish.

Pearl was one of the lucky ones. Thirteen-year-old Marion Kelly was doing homework when she saw the sea coming in, "like a mountain... but slowly". She grabbed her 3-year-old brother Elroy and jumped a fence, just as the oncoming water flowed beneath it. "I don't know how I did it," she wrote, "because Elroy was biggish." Safe on high ground, she saw the wave take her house, along with her mother and sister. Their bodies were never recovered.

Across the Gulf of St Lawrence, the people of Halifax, Nova Scotia had no idea of the disaster that had overwhelmed their neighbours in Newfoundland. In Halifax,

the earthquake had done little more than topple a few chimneys and break some dishes, and the local newspaper's main concern was to reassure its readers. There was so little to report that the *Halifax Chronicle* devoted much of its story to describing in excruciating detail how a seismometer worked and the "heroism" of local telephone operators who refused to leave their posts. Nor did the lack of communication with the Burin peninsula cause any alarm. The telegraph lines had been down for days, probably a casualty of the November weather.

The day after the quake, the *Chronicle* was able to state blithely that the most serious damage appeared to be breaks in "several cables of the Western Union Cable Company... somewhere off Newfoundland".

The quake's magnitude was later assessed at 7.2, with its epicentre beneath the Grand Banks some 250 kilometres south of

"The house was washed out to sea yet again by a third and final wave"

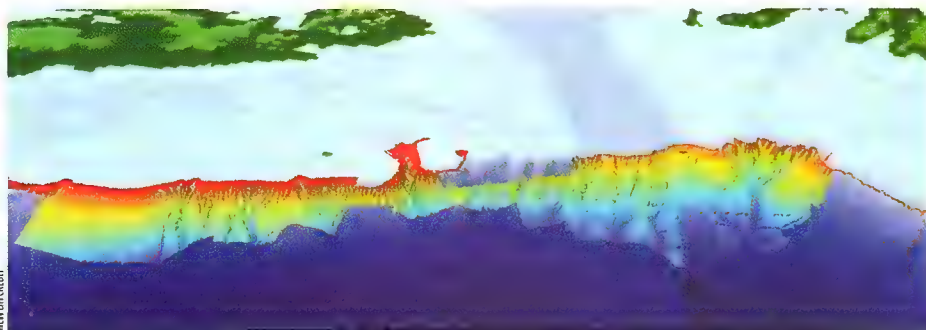
Newfoundland. Today, the offshore location of the epicentre would ring immediate alarm bells, but earthquakes are relatively rare in the Atlantic – so unusual that no one understood the implications. And tsunamis are even rarer in the Atlantic than earthquakes: even the residents of the Burin peninsula were slow to comprehend what had hit them. "We didn't know what a tidal wave was," wrote survivor Louise Emberley, who was 23 at the time. "We thought the place was sinking or something."

Scientifically, the Burin disaster posed two questions: why had there been such a big earthquake, so far from the usual tectonic centres? And why had the quake created a tsunami so strong that its ripples were felt in Portugal on the far side of the Atlantic?

The first question proved easiest to answer. Scientists now know that such quakes occur when far-away tectonic forces are transmitted to ancient, rarely active fractures. Similar quakes have been felt along the eastern seaboard of North America, from Florida to Baffin Island.

As for the tsunami, the snapped cables

After the quake, sediment avalanched down a series of submarine canyons and across the abyssal plain



You can find first-hand accounts of the Grand Banks tsunami at www.nald.ca/clr/ntla/ntla.pdf



would prove a crucial clue. All told, a dozen cables broke. Oddly, they broke in sequence, with delays of up to 13 hours – and the further the cable was from the epicentre, the longer the delay. At the time, scientists thought the breaks were caused by aftershocks, spreading slowly from the epicentre. But that made no sense because the timing of the breaks had been recorded and no corresponding aftershocks had registered on seismometers in Halifax and Boston.

The loss of the submarine cables was more than just a nuisance. “This was shortly after the Wall Street crash, and it took six months to a year to get the cables relaid,” says David Piper of the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. The breaks, he speculates, may even have contributed to the Great Depression by impeding communication between American and European banks at a critical time.

It was more than 20 years before scientists had any real inkling of what had happened. In the 1950s, geologists took core samples of the seabed and found layers of sand indicative of a large landslide. Sonar mapping then revealed that the edge of the continental shelf off the mouth of the Gulf of St Lawrence is riven by deep canyons. Gradually, oceanographers began to realise that the quake had triggered an enormous underwater landslide, shifting as much as 200 cubic kilometres of sediment. Mapping the sequence and timings of the

cable breaks revealed that debris had roared downslope at speeds of up to 67 kilometres per hour.

An ordinary landslide wouldn’t travel that fast or that far underwater. Instead, the sediment must have mixed with water to form a muddy liquid dense enough to pour downwards under its own weight – a phenomenon known as a turbidity flow. These had been produced in laboratories, but sedimentologists now realised they could happen in nature.

With the help of high-resolution multi-beam sonar, scientists are now able to chart how slabs of sediment broke off high in the canyons, then avalanched down like submarine flash floods, building up power and snapping cables as they went.

Small turbidity flows are remarkably common. In 2001, scientists at the Monterey Bay Aquarium Research Institute in Santa Cruz, California, planted some equipment at the bottom of the Monterey Canyon, a deep submarine cleft running offshore. Three months later, the gear had vanished. They found it 550 metres down the canyon, partially buried in mud. They tried again, but this time their instruments were mangled by at least two turbidity flows in just five months.

The flows in Monterey Canyon were too small to do more than wreck expensive scientific instruments, but elsewhere there’s potential for Burin-style disasters. The prime

The steamer Daisy tows a house back to the mainland of the Burin peninsula in southern Newfoundland

candidates are places where you have a combination of three factors: a sloping seabed, an earthquake and a lot of loosely consolidated sediment, deposited by a river or washed down at the end of the last ice age. “These features aren’t remarkable,” says Piper’s colleague, David Mosher. “We see similar features all along the Canadian east coast.”

Many scientists are concerned that the risk might worsen if global warming triggers the melting of underwater gas hydrates, ice-like substances produced when natural gas percolating up from below interacts with cold, high-pressure water. This could turn once-solid slopes into landslide-prone ooze.

Glacial rivers in the far north may also be setting the stage for numerous local tsunamis. In Alaska many rivers have deposited large banks of sediment at the heads of deep fjords. The last time the region was struck by a giant earthquake, in 1964, 106 residents were killed by tsunamis. Only 25 of those died in a tsunami triggered directly by the earthquake – the rest were killed by tsunamis triggered by landslides.

The Atlantic, however, is considerably less active than the Pacific. “The risk is probably small in a single person’s lifetime,” says Mosher. “But we know it does happen, because it did.” **Richard Lovett** ●



Terroir

LITERALLY, this French word means "soil". But for wine-makers, *terroir* is much more slippery. So slippery, in fact, that when oenologists, viticulturists and other interested parties got together to decide on a definition at a conference at the University of California, Davis, last year, they failed.

Conventionally, *terroir* is a geographical term. It associates the character of a wine with the particular soil and often also with the microclimate in which the grapes were grown. Location is everything.

So-called "Old World" wine-producers in Europe have clung to the idea that when it comes to Pinot noir grapes, for example, the Burgundy region is peculiarly blessed with the kind of soil and climate that bring out the best in the fruit. The belief has led some Pinot noir growers in the New World – in New Zealand and California, for example – to search for soils and microclimates that match those of Burgundy.

This idea is misguided, say some wine-makers and researchers. They believe that other factors can also determine a wine's character and that *terroir* should have a broader definition to include them. Producing

good Pinot noir wines in locations that differ substantially from Burgundy is then just a question of managing these other factors well. Some say the quality of Pinot noir in New Zealand shows this has already been achieved.

Certainly, there is a growing body of evidence to challenge the conventional wisdom relating to *terroir*. It has long been said, for instance, that the mineral constituents of a particular soil influence a wine's characteristics. However, research into why the Marlborough region of New Zealand produces such spectacular Sauvignon blancs has pretty much ruled out soil make-up. Instead, researchers think the region's climate is probably responsible.

Then there is the notion that cooler climates make for the best aromatic wines. That is clearly not the case in the Clare Valley in South Australia, which produces internationally acclaimed aromatic Rieslings though temperatures soar in summer. There must be something in the particular combination of fruit, cultivation methods, weather and soil, as well as the way in which the wine is made, that is responsible for its character. All of these factors are part of the *terroir*, say advocates of a broader definition.

No wonder delegates in California failed to reach a consensus, with some thinking it better not even to try. Nevertheless many wine-producers in Europe, and increasingly in the New World, are sticking to a narrow definition, sometimes equating *terroir* not only to a geographical region but even to a particular valley. The reason? It boosts their sales. ●

"The definition of a wine's *terroir* should not be restricted to soil and climate"

Magic bullets

Penicillin: Triumph and tragedy

by Robert Bud, Oxford University Press, ISBN 9780199254064

Reviewed by Jo Whelan



THE name "penicillin" is as evocative as any global brand. In his book, Robert Bud shows how this "miracle" tool transformed medicine's status and even hastened the sexual revolution by removing the fear of venereal disease. He also traces the emergence of antibiotic resistance, including the first case of MRSA in 1961. Surprisingly, current debates about paying for medical advances, the power of drug companies, pharmaceutical versus holistic views of disease, and drug residues in food were all hot topics in the post-war years when penicillin was first widely used. This is a highly detailed account of how we arrived at what may be the threshold of a post-antibiotic age, containing a wealth of medical and social history.

The certainty of chance

Uncertainty: Einstein, Heisenberg, Bohr, and the struggle for the soul of science

by David Lindley, Doubleday, ISBN 9780385515061

Reviewed by Marcus Chown



THERE is a fundamental limit to what we can know about the world. The more precisely we can measure the speed of a subatomic particle such as an electron, the less precisely we can know where it is located, and vice versa. Because what we know is ultimately determined by our experiments, to some extent we create the reality we observe. This idea – totally abhorrent to Einstein – goes by the name of the Heisenberg uncertainty principle. In this impressively researched book, David Lindley charts the genesis of this revolutionary idea. The book is at its best highlighting the profound alienness of the quantum world, a realm plagued by not only a fundamental "fuzziness" but also by irreducible randomness, arguably the most shocking aspect of all.

Life comes under control

Culturing Life: How cells became technologies

by Hannah Landecker, Harvard University Press, ISBN 9780674023284

Reviewed by Claire Ainsworth



THE discovery that it was possible to grow cells in a lab dish transformed them from being the immutable building blocks of individual bodies into plastic, malleable resources with a life of their own. In *Culturing Life*, anthropologist Hannah Landecker skilfully interweaves the scientific, historical and cultural aspects of this transformation, and examines how cell culture challenges humanity's notions of individuality and immortality. This disembodiment of life, she contends, has even changed the meaning of the word "biological". Although well argued, the book is peppered with sociological concepts and language that make it hard going in places for the lay reader. Nonetheless, it gives an insightful and thought-provoking perspective on how technology has changed scientists' and society's understanding of life.

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Environment Quality Division

APS Level 6 | \$59316 - \$67110 | Ref: 23305

The key duties of the positions are:

- Undertake evaluations of agricultural, veterinary and industrial chemicals for potential risks to the environment
- Undertake representation and liaison functions
- Prepare briefs and replies to Ministerial and other correspondence.

The task of assessing a chemical typically requires evaluation of studies on chemical fate and ecotoxicity, risk assessment based on predicted environmental concentrations, and the preparation of recommendations for control measures to minimise those risks.

To successfully fulfil this role, you will need:

- Sound analytical and research skills
- Good communication skills, particularly written
- A background and qualifications in relevant fields such as environmental science, chemistry, chemical/process engineering, biochemistry, life sciences, or agricultural or veterinary science.

Selection documentation may be obtained by telephoning Val Duffy on (02) 6274 1944; email val.duffy@environment.gov.au or via the Internet at

<http://www.environment.gov.au/jobs/opportunities/index.html>

After reading the selection documentation, further information about the position may be obtained from David Perry on (02) 6274 2088.

Applications must be received by COB 12 March 2007.

Applicants are advised that this process will form an order of merit that can be drawn on for the filling of future vacancies over the next 12 months.

Please note: To be eligible for employment with the Department, applicants must be Australian citizens.

Indigenous Australians are encouraged to apply.

Additional Information about the Department may be accessed via the Internet address:

<http://www.environment.gov.au>



THE solution to global warming has turned up in Feedback's spam filter. Stephen Bassett, director of the Paradigm Research Group, has written an open letter to climate activist Al Gore, copying the letter all over the place – which is why our computer intercepted it as spam.

Bassett claims the US already has the technology for dealing with the climate problem but is keeping it secret. Do you detect the whiff of a conspiracy theory? How right you are. "It was derived from the energy and propulsion systems of crashed vehicles of extraterrestrial origin," Bassett asserts. US government officials have kept it under wraps for six decades, he writes, because "it is reserved for weaponry, not for global warming response". Ah, yes. Of course.

A RARE but welcome example of marketing modesty: Ian Chapple's son's ski trousers include a tag promoting the Recco Avalanche Rescue System, which, Chapple says, appears to be some sort of passive transponder device. The tag explains: "The Recco Avalanche Rescue system utilises advanced radar technology to make a quick location of an avalanche victim possible... The Recco system consists of two parts, the reflectors, which are integrated into apparel, boots and helmets, and the search equipment, which is operated by the rescue team at the ski resort... The Recco avalanche rescue system does not prevent avalanches."

ACCOUNTANTS are used to dealing with the last penny, regardless of how unimportant it is. So perhaps Peter

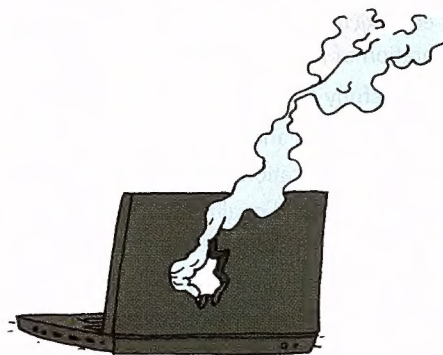
Brady shouldn't have been too surprised by the devotion to precision that he came across in the instructions for filling out a US Internal Revenue Service taxation form.

"The time needed to complete this form will vary depending on individual circumstances. The estimated average time is: record keeping, 5 hours 58 minutes; learning about the law or the form, 3 hours 46 minutes; preparing and sending the form to IRS, 4 hours 2 minutes."

We would love to know how these "estimates" were arrived at.

WE CALLED a halt to religious mondegreens – misremembered religious phrases that still make an incongruous kind of sense (2 December 2006) – but couldn't resist the one Mary Maher has told us about. A friend's daughter, she says, recently started at a denominational school in Brisbane, Australia. Maher asked her what was different about it. She said that they say prayers in the morning and elaborated by reciting the one she had just learned: "Our Father which art in heaven, Allah be thy name."

FROM the department of computer rage: Peter Brennan was working with the latest version of Adobe's Dreamweaver. When he tried to use the "recent files" list to open a file not



available on his network, a box popped up saying "No error occurred". The only other thing on the box was a button saying "OK". He pressed it and the box disappeared, but the file he wanted didn't open. He tried to open the file again and the same thing happened. Whereupon he took out a gun and shot his computer.

No, he didn't – but we wouldn't blame him if he had.

In what appears to be a special provision for the obese, a sign by the entrance of Derek Woodroffe's local home improvement store proclaims: "Larger customer parking behind the store"

THE blurb about the author on the back of David Rothery's "excellent" book, *Teach Yourself Geology*, states: "David Rothery is a senior lecturer at the Open University who has done geological research in many parts of the world, and even on some other planets."

"Gets around a bit, doesn't he?" comments Tim Walsh.

UNIVERSAL children's brick sets on sale at www.hawkin.com have many interesting features, including "soluble water". Chris Rogers wishes they'd market this separately: "So useful to take on journeys. If you are thirsty all you need is to dissolve some soluble water in... er..."

FINALLY, it is not often that we feel it appropriate to take issue with our readers, but just this once we find ourselves compelled to do so. In the 20 January issue we reported the University of Oxford's online advice that "Colleges receive around four well-qualified applicants per place, so on average two thirds of those interviewed cannot be offered a place". We went on to endorse Robert Sheehan's suggestion that the maths in this statement is flawed.

A number of readers have written in to defend Oxford, contending, for example, that the numbers will work perfectly well "if a quarter of the applicants decide not to turn up for the interview". This is true – and we could add that the numbers would also work perfectly well if Oxford scouts were sent out to dispose of a quarter of the applicants in acid baths. However, neither these nor any other possible explanations appear in the statement from the university that we quoted. Without them it is, we insist, flawed.

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week's and past Feedbacks can be seen on our website.

The last word

Last Words past and present, plus a full list of unanswered questions, are available on New Scientist's website at www.newscientist.com

STRINGS ATTACHED

While on holiday in Greece, we found some strange eggs in the sea. They were composed of a jelly-like substance with an embryo clearly visible (see Photo, below left). Whatever laid them was obviously quite big because the eggs formed long strings similar to toad spawn. The eggs pulsated if they were taken out of water. Can anyone identify them?

● These are not actually eggs at all. The picture shows a gelatinous creature called a salp. These pelagic tunicates are often barrel-shaped and at least partially hollow. Believe it or not, they belong to the chordate phylum, the same as humans.

The questioner mentions that the "eggs" pulsated when lifted out of the

water. This means they were holding a live salp. If you spotted one in the water – say when snorkelling – you would be able to see that the salp moves by contracting its main body walls and pumping out water. The opaque part in the photograph described as the "embryo" is in fact the salp's digestive and primitive nervous system. Salps can be free individuals or form strings (see Photo, below right) – some species even create huge mats or large hollow bodies many metres long which almost replicate their individual body shape on a giant scale.

Salps feed on plankton and are common in most waters, but more so

"Salps may look like jellyfish, but they are in our phylum – a strange not-quite-vertebrate-not-quite-invertebrate"

in temperate and equatorial climes. They reproduce very quickly by budding off clones as a direct response to plankton blooms. Often, after plankton blooms have faded, dead or dying salps wash up on beaches or form tidal bands before sinking to the sea floor.

*Dave Banks
Wellington, New Zealand*

● Salps are pretty cool. Picture a transparent gelatinous barrel, open at both ends, with ring-like muscle bands and a primitive proto spinal cord (known as a notochord). They are a pelagic version of sea squirts, or tunicates, meaning that they spend their whole life high up in the water rather than stuck to the bottom. They move swiftly by jet propulsion.

The "long strings similar to toad spawn" that are described are the colonial part of the life cycle, where a

nurse mother clones off many juveniles that remain stuck together while they grow.

They may look like jellyfish, but they are actually members of our phylum – a sort of a strange not-quite-vertebrate-not-quite-invertebrate link in the tree of life.

They are vegetarians, filtering plankton from the water, and are often highly bioluminescent (providing unlimited entertainment for bio-nerds like me). They are also the primary biological indicator that we use in Australia to predict and detect the presence of a type of dangerous jellyfish called an irukandji. So, these gelatinous vegetarian barrel cousins of humans also actually help us to keep our beaches safe.

*Lisa-Ann Gershwin
State Marine Stinger Advisor
Brisbane, Queensland, Australia*



THIS WEEK'S QUESTIONS

Think hard

What is the storage capacity of the human brain in gigabytes? If we were to construct a PC with similar computational power to our brain, what would its technical specifications need to be?

*John Gladstone
Southampton, UK*

Numbstruck

Why do we sometimes get "pins and needles", especially in our arms and legs, and what exactly occurs in our bodies to make this happen?

*Kunal Patel
London, UK*

Questions and answers should be kept as concise as possible. We reserve the right to edit items for clarity and style. Please include a daytime telephone number and a fax if you have one. Questions should be restricted to scientific enquiries about everyday phenomena. The writers of all answers that are published will receive a cheque for £25 (or the US\$ equivalent). Reed Business Information Ltd reserves all rights to reuse question and answer material submitted

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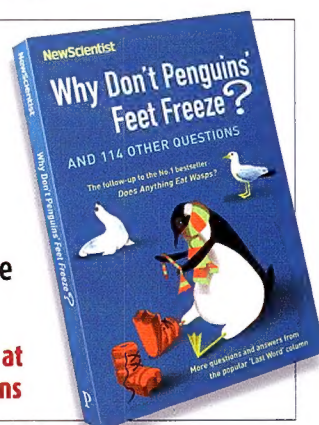
Memorable answer? The Last Word and New Scientist have teamed up with Crucial Technology (www.crucial.com/uk) and will be awarding each successful author a 512MB Gizmo! overdrive.



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CAN YOU TELL WHERE IT'S BEEN JUST FROM ITS SPOTS?



Marine conservationist Brad Norman can. He's developed a photo-identification system that identifies individual whale sharks from the unique set of spots on their skin, enabling him to chart their migratory routes and so aid their conservation. He's just one of the five 2006 Rolex Laureates whose groundbreaking endeavours have been selected by a panel of distinguished judges for their potential to expand human knowledge or improve the lot of mankind. The winners each receive a gold Rolex chronometer and US \$100,000 towards the completion of their projects. Which, for Brad Norman, will mean that one day we'll know where every whale shark's been just from its spots.

CHANDA SHROFF

Reviving Kutchi embroidery and thereby the fortunes of local women.



RORY WILSON

Inventing an energy-use monitor to help safeguard endangered species.



ALEXANDRA LAVRILLIER

Preserving the nomadic culture of the Evenk through a nomadic school.



BRAD NORMAN

Creating a whale-shark recognition system to aid its conservation.



PILAI POONSWAD

Saving Thailand's hornbills from the threat of poaching and deforestation.

